Author: Jan Walleckec
Category: Trustee Memos
Date: April 23, 2020

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> "I feel that we are on the threshold of a new order where people will be seeking enlightened change. ... This will all come about with the infusion of spirituality into science. The Foundation's eventual intent is to integrate the scientific process with spiritual mindedness … A fundamental key to all this is to conduct this search with a proper line of scientific investigation."

In the last ten years, Fetzer Franklin led breakthroughs in the following areas:

1. Relational Reality – the concept of the interconnection of all things at the quantum level now exists within mainstream physics academies in the world.
2. Metascience – the scientific study of the scientific method is a high priority for most major funding institutions in the world.
3. Advanced Protocols to study anomalous phenomena are becoming accepted. This could present an opportunity to advance mainstream investigation of extreme possibilities in the area of psi and subtle energy research. Psi, energy medicine, and subtle energy were dominant interests of John Fetzer. These revolutionary advanced protocols could help discern real effects from false positive effects which would catalyze substantial interest in these fields.

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Participation

EmQM17 - Towards Ontology of Quantum Mechanics and the Conscious Agent

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Profile

AEPHRAIM STEINBERG

CQIQC, University of Toronto

Aephraim Steinberg is a Professor in the Department of Physics at the University of Toronto. He is also a founding member of Toronto's Institute for Optical Sciences, a member and past director of the Centre for Quantum Information and Quantum Control (CQIQC), an affiliate member of the Perimeter Institute for Theoretical Physics and a principal investigator in Photonics Research Ontario, the Canadian Institute for Photonic Innovations, and QuantumWorks.

Dr. Steinberg received his undergraduate degree from Yale University in 1988 and his Ph.D. from the University of California at Berkeley in 1994. He then held post-doctoral fellowships at the Université de Paris VI and the U.S. National Institute of Standards and Technology before moving to Toronto in 1996. He has been a guest professor at the University of Vienna; the Institut d'Optique Théorique et Appliquée in Orsay, France; and the University of Queensland in Australia.

In 2006, he received the Canadian Association of Physicists Herzberg Medal and the Rutherford Medal in Physics from the Royal Society of Canada. In 2007, he received a Steacie Fellowship from NSERC, and a McLean Fellowship (Connaught Foundation, University of Toronto). He is a Fellow of the Institute of Physics (UK), the American Physical Society, and the Optical Society of America.

He joined CIFAR's *Quantum Information Science* Program in 2003.

Dr. Steinberg's interests lie in fundamental quantum-mechanical phenomena and the control & characterization of the quantum states of systems ranging from laser-cooled atoms to individual photons. His experimental program is two-pronged, using both nonclassical two-photon interference and laser-cooled atoms to study issues such as quantum information & computation, decoherence and the quantum-classical boundary, tunneling times, weak measurement & retrodiction in quantum mechanics, and the control and characterization of novel quantum states.

(source: University of Toronto)

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Probing "surreal" elements of quantum physics using weak measurements

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Paper
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Paper
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Profile

ANA MARÍA CETTO

Universidad Nacional Autónoma de México, MX

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Prof. Ana María Cetto, Research professor of the Institute of Physics and lecturer at the Faculty of Sciences, Universidad Nacional Autónoma de México. Ana María Cetto is a full-time research Professor at the Institute of Physics, and lecturer at the Faculty of Sciences, Universidad Nacional Autónoma de México (UNAM). She holds an M.A. in Biophysics from Harvard University and a M.S c and Ph.D in Physics from UNAM. Her main field of research is theoretical physics, with emphasis on the foundations of quantam mechanics, where she has contributed substantially to the development of stochastic electrodynamics. She is co-author of "The Quantum Dice" (Kluwer, 1996). Prof. Cetto is the former Dean of the Faculty of Sciences, and former head of the Theoretical Physics Department at the Institute of Physics. She chaired the project for the Museum on Light (UNAM), inaugurated in 1996. She served as consultant for the UNESCO World Conference of Science (1999). From 2003 to 2010 she served as Deputy Director General of the International Atomic Energy Agency (Nobel Peace Prize 2005), where she headed the Department of Technical Cooperation. She is founding President of LATINDEX, online information system for Ibero-American and Caribbean scholary journals. Prof Cetto has held honorary positions in a number of international organisations, such as the Executive Boards of Interciencia Association, Third World Organisation for Women in Science (TWOWS, Co-founder) and International Council for Science (ICSU), the Board of Trustees of International Foundation for Science (IFS), the Governing Board of United Nations University (UNU), the Council of International Network of Engineers and Scientists (INES) and the Executive Committee of Pugwash Conferences (Nobel Peace Prize 1995). She was appointed Mexico's Woman of the Year in 2003.

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EmQM17 - Towards Ontology of Quantum Mechanics and the Conscious Agent

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Profile

ANDREI KHRENNIKOV

International Center for Mathematical Modelling in Physics and Cognitive Sciences, Linnaeus University,

Andrei Khrennikov is Professor of Mathematics at the Department of Mathematics at Linnaeus University. Andrei is also director of the research group International Center for Mathematical Modeling (ICMM) and organizer of some 20 conferences in the field of quantum theory at Linnaeus University.His research activity can be characterized as extensively multi-disciplinary.

The research activities are split in the basic disciplines: Mathematics, physics, and biology, cognition, psychology and behavioral economics.

(source: Linnaeus University)

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Participation

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Profile

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Particles, Waves and Trajectories: 210 Years After Young's Experiment

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SPEAKER
Angelo Bassi

PLACE
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FIELD OF SCIENCE
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COLLAPSE MODELS: FROM THEORETICAL FOUNDATIONS TO EXPERIMENTAL VERIFICATIONS

Angelo Bassi Austrian Academy of Sciences – Festsaal

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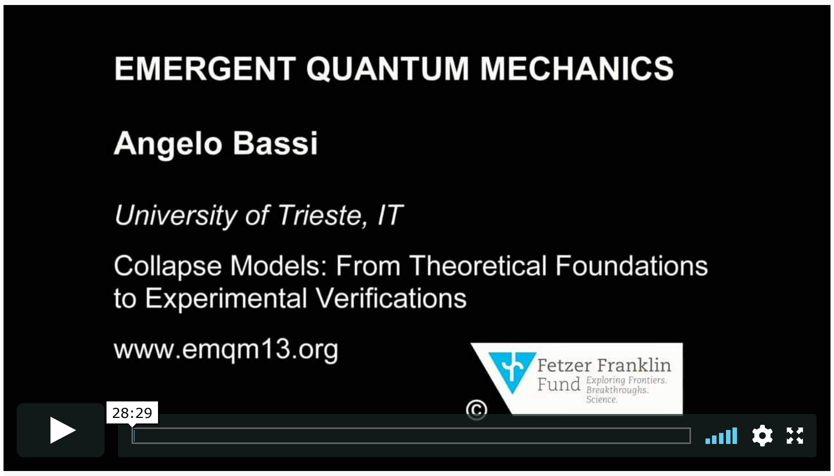

The basic strategy underlying models of spontaneous wave function collapse (collapse models) is to modify the Schroedinger equation by including nonlinear stochastic terms, which tend to localize wave functions in space in a dynamical manner. These terms have negligible effects on microscopic systems – therefore their quantum behaviour is practically preserved. On the other end, since the strength of these new terms scales with the mass of the system, they become dominant at the macroscopic level, making sure that wave functions of macro-objects are always well-localized in space. Based on recent results, we discuss why modifications of the Schroedinger equation which include nonlinear stochastic terms have to be of the form used in collapse models. Therefore, in a precise sense, collapse models are the only consistent modifications of quantum mechanics, preserving general physical principles. By changing the dynamics of quantum systems, collapse models make predictions, which are different from standard quantum mechanical predictions. Although they are difficult to detect, we discuss the most relevant scenarios, where such deviations could possibly be observed.

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Participation

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Profile

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Angelo Bassi was born in Udine (Italy) in 1973. He was awarded the degree in Physics (Summa cum laude) at the University of Trieste in 1998 and the Ph.D. in Physics in 2001. Subsequently he was Post Doctoral Fellow and Visiting Scientist at the ICTP in Trieste (2002/04) and Marie-Curie Fellow at the University Ludwig-Maximillian of Munich (2004/06). In December 2006 he became staff member of the Department of Physics of the University of Trieste.

He published about 50 articles in international Journals, among which: 1 Science, 4 PRL, 1 Rev. Mod. Phys, 1 Phys. Rept. He is referee for the APS and IOP journals, and for the American NSF. He is co-organizer of 9 international conferences, workshops, schools on Quantum Mechanics and related topics. He was invited speaker at 25 international conferences and schools. He was guest editor of the special issue of Journal of Physics A: "The Quantum Universe" (2007). He is Chair of the COST Action Fundamental Problems in Quantum Physics

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Participation

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Profile

ARIEL CATICHA

Department of Physics, University at Albany, USA

Professor and Associate Chair of Physics Ariel Caticha strongly believes that "physics is learned by doing." To encourage students to join him on his voyage of discovery, the scholar – internationally recognized for his work on a "theory of X-ray and neutron scattering by thin film multilayers" and "capillary waveguides for soft X-rays and neutrons" – makes himself accessible to his undergraduate and graduate students both inside and outside the classroom.

Caticha is also noted for his enthusiasm and for his ability to convey subtle concepts. These talents, combined with his accessibility, consistently earn him high marks from students who evaluate his teaching.

To date, Caticha has mentored six students toward their doctoral dissertations. In addition, he has served as a reviewer of National Science Foundation research grant proposals. The author of numerous peer-reviewed and invited articles, Caticha also referees such scientific journals as Physical Review Letters, Journal of Physics, and Journal of the Optical Society of America.

VIDEOS WITH ARIEL CATICHA

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Profile

BASIL J. HILEY

Theoretical Physics Research Unit, University of London

Basil J. Hiley is a British quantum physicist and professor emeritus of the University of London. He received the Majorana Prize "Best person in physics" in 2012.

Long-time co-worker of David Bohm, Hiley is known for his work with Bohm on implicate orders and for his work on algebraic descriptions of quantum physics in terms of underlying symplectic and orthogonal Clifford algebras. Hiley co-authored the book The Undivided Universe with David Bohm, which is considered the main reference for Bohm's interpretation of quantum theory.

The work of Bohm and Hiley has been characterized as primarily addressing the question "whether we can have an adequate conception of the reality of a quantum system, be this causal or be it stochastic or be it of any other nature" and meeting the scientific challenge of providing a mathematical description of quantum systems that matches the idea of an implicate order.

Basil Hiley was born 1935 in Burma, where his father worked for the military for the British Raj. He moved to Hampshire, England, at the age of twelve, where he attended secondary school. His interest in science was stimulated by his teachers at secondary school and by books, in particular The Mysterious Universe by James Hopwood Jeans and Mr Tompkins in Wonderland by George Gamow.

Hiley performed undergraduate studies at King's College London. He published a paper in 1961 on the random walk of a macromolecule, followed by further papers on the Ising model, and on lattice constant systems defined in graph theoretical terms. In 1962 he obtained his PhD from King's College in condensed matter physics, more specifically on cooperative phenomena in ferromagnets and long chain polymer models, under the supervision of Cyril Domb and Michael Fisher.

Hiley first met David Bohm during a week-end meeting organized by the student society of King's College at Cumberland Lodge, where Bohm held a lecture. In 1961 Hiley was appointed assistant lecturer at Birkbeck College, where Bohm had taken the chair of Theoretical Physics shortly before. Hiley wanted to investigate how physics could be based on a notion of process, and he found that David Bohm held similar ideas. He reports that during the seminars he held together with Roger Penrose he was particularly fascinated by John Wheeler's "sum over three geometries" ideas that he was using to quantise gravity.

Hiley worked with David Bohm for many years on fundamental problems of theoretical physics. Initially Bohm's model of 1952 did not feature in their discussions; this changed when Hiley asked himself whether the "Einstein-Schrödinger equation", as Wheeler called it, might be found by studying the full implications of that model. They worked together closely for three decades. Together they wrote many publications, including the book The Undivided Universe: An Ontological Interpretation of Quantum Theory, published 1993, which is now considered the major reference for Bohm's interpretation of quantum theory.

In 1995, Basil Hiley was appointed to the chair in physics at Birkbeck College at the University of London. He was awarded the 2012 Majorana Prize in the category The Best Person in Physics for the algebraic approach to quantum mechanics and furthermore in recognition of "his paramount importance as natural philosopher, his critical and open minded attitude towards the role of science in contemporary culture".

(source: Wikipedia)

VIDEOS WITH BASIL J. HILEY

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Paper
EmQM15 – Weak Values, Local Momentum and Tangent Groupoids

Paper
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Info

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Profile

BEI-LOK HU

Maryland Center for Fundamental Physics and Joint Quantum Institute University of Maryland

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Prof Bei-Lok Hu got his PhD in theoretical physics from Princeton University in 1972 under the late Professor John A. Wheeler. After postdoctoral work at Stanford University, University of California, Berkeley and Santa Barbara in mathematics, physics and astrophysics, he was appointed an honorary research fellow at Harvard University in 1979 before he assumed his current position at the University of Maryland in 1980.

Prof Hu's research in the 70's was on quantum field theory in curved spacetime with applications to quantum processes in the early universe, for that work he was elected Fellow of the American Physical Society. Professor Hu began pioneering work on nonequilibrium quantum field theory in the 80's which resulted in a book with Dr. Calzetta by this title published in 2008 in the Cambridge Monograph in Mathematical Physics series. In 1990 Prof Hu began his seminal work on quantum decoherence and non-Markovian processes of open quantum systems. Since 2000 he has been studying quantum entanglement dynamics in atomic-optical systems with applications to quantum information processing. He is a founding fellow of the Joint Quantum Institute dedicated to the advancement of quantum science and its applications. He is also the chief architect in the inauguration of the International Society for Relativistic Quantum Information in 2010. His current research interest is on foundational issues of quantum and statistical mechanics behind macroscopic quantum phenomena and quantum thermodynamics.

Prof Hu is a world-renowned leader in quantum gravity research. His long-held critically independent viewpoint that general relativity is a hydrodynamic theory first presented at the Second Sakharov Conference in 1996 has, alongside with his Maryland colleague Jacobson's 1995 paper on viewing Einstein's equation as an equation of state, as well as work from the condensed matter community by Volovik and Wen, helped ushered in a vibrant field known today as emergent gravity.

(source: HKUST Jockey Club Institute for Advanced Study)

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Paper
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Participation

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Profile

BORIS BRAVERMAN

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In recent years, it was realized that weak measurements on many copies of a system can be used to directly extract its quantum features. In a deterministic view of quantum theory, such as Bohmian mechanics, one can even acquire information that is normally inaccessible – for example, measuring simultaneously the position and momentum of a particle. This allows the direct measurement of Bohmian trajectories. I will discuss how the sub-quantum features revealed in these trajectories bring into focus the non-local nature of quantum theory and highlight its essential strangeness, as well as pave the way toward an understanding of the qualities of post-quantum theories.

VIDEOS WITH BORIS BRAVERMAN

VIDEO

PHYSICS
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Paper
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Presentation
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Physics

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Paper

EMQM13 – QUANTUM INDEFINITENESS OF CAUSAL RELATIONS

Časlav Brukner, Vienna Center for Quantum Science and Technology, University of Vienna, AT

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Abstract

Quantum mechanics differs from classical physics in that no definite values can be attributed to unobserved physical quantities. However, the notion of time and of causal order preserves such an objective status in the theory: all operations are assumed to be ordered such that every operation is either in the future, in the past or space-like separated from any other operation. Consequently, the correlations between operations respect definite causal order: they are either signalling correlations for the time-like or no-signalling correlations for the space-like separated operations. I will present a framework that assumes only that operations in local laboratories are described by quantum mechanics (i.e. are completely-positive maps), but relax the assumption that they are causally connected. Remarkably, we find situations where two operations are neither causally ordered nor in a probabilistic mixture of definite causal orders, i.e. one cannot say that one operation is before or after the other. The correlations between the operations are shown to enable communication and computation that are impossible if the operations are ordered according to a fixed background time. In a classical limit causal order always arises, which suggests that space-time and definite causal relations may emerge from a more fundamental structure in a quantum-to-classical transition.

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Since 2008 Visiting Professor, University of Belgrade, Serbia

Since 2006 Faculty member, Doctoral Program "Complex Quantum Systems" (www.coqus.at) at the University of Vienna, and Vienna University of Technology

2003-2013 Außerordentlicher Professor, Faculty of Physics, University of Vienna

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2005-2007 Chair Professor, Tsinghua University, Beijing, China

2004 Marie Curie Fellow, Imperial College London, UK

1999-2003 Vertragsassistent, Faculty of Physics, University of Vienna, Austria.

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Profile

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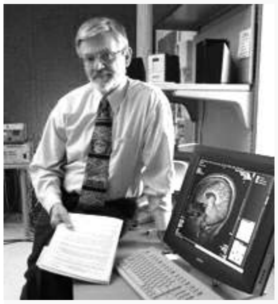

Christopher Green, M.D., Ph.D., FAAFS is Professor and Assistant Dean for China/Asia Pacific at Wayne State University School of Medicine, and at Detroit Medical Center Departments of Diagnostic Radiology and Psychiatry, and at the Chinese Academy of Sciences. Previously he was Assistant National Intelligence Officer Executive Branch, US Government, and later Chief Technology Officer Asia-Pacific General Motors. He also lived in Washington D.C., China and Singapore.

Kit founded and serves on the boards of several international neurotechnology and genomic companies. He uses high-field MRI for patients with complex forensic neurological disorders. He pursued his Ph.D. and M.D. degrees at Wisconsin, Colorado, and Ciudad Juarez University Schools of Medicine and is medically licensed in many states and WHO countries. As Holder of the National Intelligence Medal, and Lifetime Member of the National Research Council and the National Academy of Sciences, Kit has served and chaired numerous Department of Defense Science Boards and has authored over 20 academic monographs and studies in neurology, and biophysics. His passion is in brain imaging, neurotoxicology and genomics, and cognition. He is a Fellow in the American Academy of Forensic Sciences.

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Dieter Schuch (1953 in Frankfurt am Main) ist ein deutscher Chemiker (Theoretische Chemie). Er ist Professor an der Goethe-Universität Frankfurt am Main.
Schuch studierte ab 1973 Chemie (und Physik) an der Universität Frankfurt mit dem Diplom 1978 bei Hermann Hartmann (Untersuchungen der Spin-Bahn-Wechselwirkung für ein Problem mit torusförmiger Potentialmulde) und der Promotion 1982 (Theoretische Hilfsmittel zur Beschreibung der Ionenbewegung in der Ionen-Cyclotron-Resonanz-Spektrometrie). Er war Redakteur der Theoretica Chimica Acta, war 1986 Gastdozent be IBM Kingston in New York und habilitierte sich 1992 in Frankfurt (Komplexe nichtlineare Zusammenhänge im Rahmen einer wellenmechanischen Beschreibung reversibler und irreversibler Dynamik), mit Kyu-Myung Chung als Berater. Danach war er untere anderem bei Peter Schwerdtfeger in Auckland und bei Marcos Moshinsky in Mexiko-Stadt. 2002 wurde er außerplanmäßiger Professor am Institut für Theoretische Physik in Frankfurt.
Er befasst sich mit exakt lösbaren Problemen in klassischer Physik und Quantenmechanik, dahinter stehender Gruppentheorie und dynamischen Symmetrien einschließlich Supersymmetrie, Irreversibilität in klassischer und quantenmechanischer Dynamik (und Roll der Zeit), Übergängen zwischen klassischer und Quantenmechanik (Semiklassische Näherung) und nichtlinearen Formulierungen und Erweiterungen der Quantenmechanik.

VIDEOS WITH DIETER SCHUCH

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Is Quantum Mechanics Emerging from a Nonlinear Theory?

PAPERS FROM DIETER SCHUCH

Paper
EmQM13 – Is Quantum Mechanics Emerging from a Nonlinear Theory?

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EmQM13 - Emergent Quantum Mechanics

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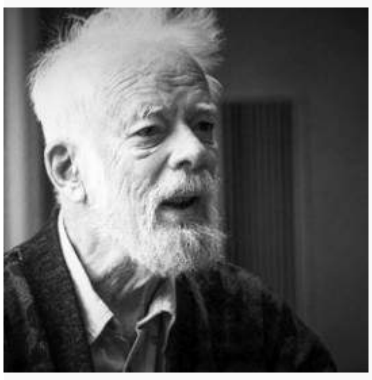
Profile

EDWARD NELSON

Department of Mathematics, Princeton University, USA



Edward Nelson (May 4, 1932 - September 10, 2014) was a professor in the Mathematics Department at Princeton University. He was known for his work on mathematical physics and mathematical logic. In mathematical logic, he was noted especially for his internal set theory, and his controversial views on ultrafinitism and the consistency of arithmetic. He also wrote on the relationship between religion and mathematics.

Nelson was born in Decatur, Georgia. He received his Ph.D. in 1955 from the University of Chicago, where he worked with Irving Segal. He was a member of the Institute for Advanced Study from 1956 to 1959. He held a position at Princeton University starting in 1959, attaining the rank of professor there in 1964 and retiring in 2013.

In 2012 he became a fellow of the American Mathematical Society. He died in Princeton, New Jersey on September 10, 2014.

Nelson made contributions to the theory of infinite-dimensional group representations, the mathematical treatment of quantum field theory, the use of stochastic processes in quantum mechanics, and the reformulation of probability theory in terms of non-standard analysis.

For many years he worked on mathematical physics and probability theory, and retained a residual interest in these fields, particularly in possible extensions of stochastic mechanics to field theory.

In 1950, Nelson formulated a popular variant of the four color problem. What is the chromatic number, denoted \chi, of the plane? In more detail, what is the smallest number of colors sufficient for coloring the points of the Euclidean plane in such a way that no two points of the same color are unit distance apart? We know by simple arguments that $4 \le \chi \le 7$. The problem was introduced to a wide mathematical audience by Martin Gardner in his October 1960 Mathematical Games column. The chromatic number problem, also now known as the Hadwiger-Nelson problem, was also a favorite of Paul Erdős, who mentioned it frequently in his problems lectures.

In the later part of his career, he worked on mathematical logic and the foundations of mathematics. One of his goals was to extend IST (Internal Set Theory—a version of a portion of Abraham Robinson's non-standard analysis) in a natural way to include external functions and sets, in a way that provides an external function with specified properties unless there is a finitary obstacle to its existence. Other work centered on fragments of arithmetic, studying the divide between those theories interpretable in Raphael Robinson's Arithmetic and those that are not; computational complexity, including the problem of whether P is equal to NP or not; and automated proof checking.

In September 2011, Nelson announced that he had proved that Peano arithmetic was logically inconsistent. An error was found in the proof, and he retracted the claim.

VIDEOS WITH EDWARD NELSON

VIDEO
PHYSICS
Stochastic Mechanics Applied to Relativistic Fields

PAPERS FROM EDWARD NELSON

Paper
EmQM13 – Stochastic Mechanics Applied to Relativistic Fields

Presentation
EmQM13 – Stochastic Mechanics Applied to Relativistic Fields

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Info

NAME
EmQM13 - Emergent Quantum Mechanics

DATE
03/10 - 06/10/2013

VENUE
Austrian Academy of Sciences, Vienna

FIELD OF SCIENCE
Foundations, Physics

WEBSITE
www.emqm13.org

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Event

EMQM13 – EMERGENT QUANTUM MECHANICS

03/10 – 06/10/2013, Austrian Academy of Sciences, Vienna

Speakers *Videos* *Papers* *Schedule*

The symposium invites the open exploration of an emergent quantum mechanics, a possible "deeper level theory" that interconnects three fields of knowledge: emergence, the quantum, and information. Could there appear a revised image of physical reality from recognizing new links between emergence, the quantum, and information? Could a novel synthesis pave the way towards a 21st century, »super-classical« physics? The symposium provides a forum for discussing (i) important obstacles which need to be overcome as well as (ii) promising developments and research opportunities on the way towards an emergent quantum mechanics. Contributions are invited that present current advances in both standard as well as unconventional approaches to quantum mechanics.

Our symposium was open to the public, with free attendance.

SPEAKERS

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Biology, Physics

MARKUS ARNDT
Physics

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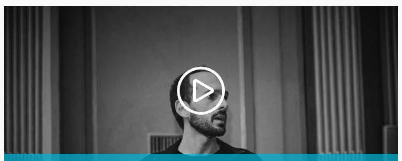
The Time-Symmetric Formulation of...



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Paper
EmQM13 – Quantum Indefiniteness of Causal Relations

Paper
EmQM13 – Causality and Local Determinism versus Quantum Nonlocality

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SCHEDULE

DAY /2013 | THURSDAY 03/10/2013 | FRI 04/10

19:00-19:30
OPENING EVENT: »THE FUTURE OF QUANTUM MECHANICS«

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Participation

EmQM13 - Emergent Quantum Mechanics

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Profile

GARNET ORD

Department of Physics, Ryerson University, CA

Garnet Ord is a Faculty member in the mathematics department at Ryerson university. Much of his research looks for a statistical mechanical layer beneath quantum mechanics.

VIDEOS WITH GARNET ORD

VIDEO

PHYSICS
Which Comes First, Time or the Clock that Measures It?

PAPERS FROM GARNET ORD

Paper
EmQM13 – Which Comes First, Time or the Clock that Measures It?

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Participation

EmQM15 - Emergent Quantum Mechanics

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Profile

GERARD 'T HOOFT

Institute for Theoretical Physics, Department of Physics and Astronomy, Faculty of Science of Utrecht University, NL

His work concentrates on gauge theory, black holes, quantum gravity and fundamental aspects of quantum mechanics. His contributions to physics include a proof that gauge theories are renormalizable, dimensional regularization, and the holographic principle. After obtaining his doctorate 't Hooft went to CERN in Geneva, where he had a fellowship. He further refined his methods for Yang-Mills theories with Veltman (who went back to Geneva). In this time he became interested in the possibility that the strong interaction could be described as a massless Yang-Mills theory, i.e. one of a type that he had just proved to be renormalizable and hence be susceptible to detailed calculation and comparison with experiment.

According to his calculations, this type of theory possessed just the right kind of scaling properties (asymptotic freedom) that this theory should have according to deep inelastic scattering experiments. This was contrary to popular perception of Yang-Mills theories at the time, that like gravitation and electrodynamics, their intensity should decrease with increasing distance between the interacting particles; such conventional behaviour with distance was unable to explain the results of deep inelastic scattering, whereas 't Hooft's calculations could. When he mentioned his results at a small conference at Marseilles in 1972, Kurt Symanzik urged him to publish this result. He did not, and the result was eventually rediscovered and published by Hugh David Politzer, David Gross, and Frank Wilczek in 1973, which led to them earning the 2004 Nobel Prize in Physics.

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PHYSICS
How quantization of gravity leads to a discrete space-time

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The Future of Quantum Mechanics - EmQM13 Opening Speech

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Info

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Participation

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Profile

GERHARD GRÖSSING

Austrian Institute for Nonlinear Studies

Dr. Gerhard Grössing is Co-Founder and Director of the Austrian Institute for Nonlinear Studies (AINS) in Vienna, Austria. He studied physics and mathematics at the University of Vienna and at Iowa State University, USA. During his post-doctoral work at Vienna's Atominstitut, he coined the term and developed, together with Anton Zeilinger, the first "Quantum Cellular Automata", and he developed an early variant of an "emergent" quantum theory named "Quantum Cybernetics" whose main results were published as a monograph with Springer Verlag, New York.

His major research interests cover the foundations of quantum theory and new tools in complex systems research. Apart from his scientific work per se, he has a continued interest in the fields of philosophy and foundations of science, where he also published numerous articles and two books. In recent years, the research of Gerhard Grössing and the AINS has focused on the development of an "Emergent Quantum Mechanics". He has organized at the University of Vienna the first international conference exclusively devoted to this promising and rapidly developing field, whose contributions are collected in a volume published by the Institute of Physics

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Paper
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Paper
EmQM13 – Emergent Quantum Mechanics

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Info

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FIELD OF SCIENCE
Foundations, Physics

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Paper

EMQM13 – EMERGENT QUANTUM MECHANICS

Gerhard Grössing, Hans-Thomas Elze, Jan Walleczek, Austrian Institute for Nonlinear Studies, Dipartimento di Fisica "Enrico Fermi", Università di Pisa, Phenoscience Laboratories

Download paper

Abstract

These proceedings comprise the invited lectures of the second international symposium on Emergent Quantum Mechanics (EmQM13), which was held at the premises of the Austrian Academy of Sciences in Vienna, Austria, 3-6 October 2013.

The symposium was held at the "Theatersaal" of the Academy of Sciences, and was devoted to the open exploration of emergent quantum mechanics, a possible "deeper level theory" that interconnects three fields of knowledge: emergence, the quantum, and information. Could there appear a revised image of physical reality from recognizing new links between emergence, the quantum, and information? Could a novel synthesis pave the way towards a 21st century, "superclassical" physics? The symposium provided a forum for discussing (i) important obstacles which need to be overcome as well as (ii) promising developments and research opportunities on the way towards emergent quantum mechanics. Contributions were invited that presented current advances in both standard as well as unconventional approaches to quantum mechanics.

The EmQM13 symposium was co-organized by Gerhard Grössing (Austrian Institute for Nonlinear Studies (AINS), Vienna), and by Jan Walleczek (Fetzer Franklin Fund, USA, and Phenoscience Laboratories, Berlin). After a very successful first conference on the same topic in 2011, the new partnership between AINS and the Fetzer Franklin Fund in producing the EmQM13 symposium was able to further expand interest in the promise of emergent quantum mechanics.

The symposium consisted of two parts, an opening evening addressing the general public, and the scientific program of the conference proper. The opening evening took place at the Great Ceremonial Hall (Grosser Festsaal) of the Austrian Academy of Sciences, and it presented talks and a panel discussion on "The Future of Quantum Mechanics" with three distinguished speakers: Stephen Adler (Princeton), Gerard 't Hooft (Utrecht) and Masanao Ozawa (Nagoya).

The articles contained in these proceedings represent the talks of the invited speakers as written immediately after the symposium. The volume starts with a contribution by organizers Jan Walleczek and Gerhard Grössing, essentially explaining why emergent quantum mechanics, and other deterministic approaches to quantum theory, must be considered viable approaches in quantum foundations today. This is followed by the exposition of Stephen Adler's talk who introduced to a general audience key questions at the current frontiers of quantum mechanics during the opening evening (with the contents of his conference talk appearing elsewhere). The conference proceedings then continues with the presentations as given in their chronological order i.e. starting with the opening talk of the scientific program by Gerard 't Hooft. While the page number was restricted for all invited speakers, the paper by Jeff Tollaksen was given more space, as his invited collaborator Yakir Aharonov was unable to deliver a separate talk, in order to represent both contributions in one paper. Note that the talks of all speakers, including the talks of those who could not be represented in this volume (M. Arndt, B. Braverman, C. Brukner, S. Colin, Y. Couder, B. Poirier, A. Steinberg, G. Weihs and H. Wiseman) are freely available on the conference website as video presentations (http://www.emqm13.org).

The organizers wish to express their gratitude to Siegfried Fussy and Herbert Schwabl from AINS for the organizational support. The organizers also wish to thank Bruce Fetzer, President and CEO, John E. Fetzer Memorial Trust, and the Members of the Board of Trustees, for their strong support and for funding this symposium.

We also wish to thank the Austrian Academy of Sciences for allowing the symposium to be held on their premises, and Anton Zeilinger, President of the Austrian Academy of Sciences, for his welcome address. The expertise of the Members of the Scientific Advisory Board of the EmQM13 symposium, Ana Maria Cetto (Mexico), Lajos Diósi (Budapest), Maurice de Gosson (Vienna), Edward Nelson (Princeton), Theo Nieuwenhuizen (Amsterdam) and Helmut Rauch (Vienna), is also gratefully acknowledged.

Finally, it is a pleasure to again thank Sarah Toms and her team at IOP Publishing (Bristol) for their friendly advice and help during the preparation of these proceedings.

Vienna, Pisa, Berlin, February 2014

Gerhard Grössing,

Hans-Thomas Elze,

Johannes Mesa Pascasio,

Jan Walleczek

The front cover image shows two bouncing oil droplets on an oscillating oil surface, as they are employed by Couder, Fort, Bush, and others to show macroscopic analogues of wave-particle complementarity (courtesy of Dan Harris and John Bush, MIT).

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Infos

SPEAKER
Gerhard Grössing, Jan Walleczek

PLACE
Austrian Academy of Sciences – Festsaal

FIELD OF SCIENCE
Physics

DATE
03/10/2013

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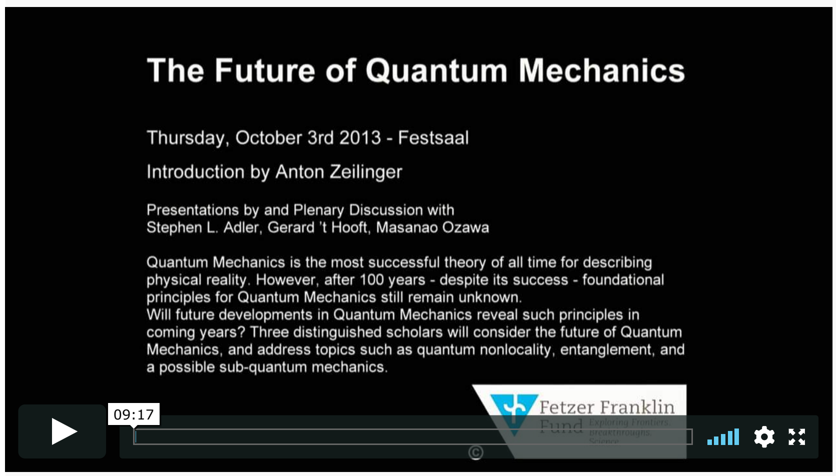
THE FUTURE OF QUANTUM MECHANICS – EMQM13 OPENING SPEECH

Gerhard Grössing, Jan Walleczek Austrian Academy of Sciences — Festsaal



Introduction by: Anton Zeilinger

Presentations by and Plenary Discussion with Stephen L. Adler, Gerard ´t Hooft. Masanao Ozawa

Quantum Mechanics is the most successful theory of all time for describing physical reality. However, after 100 years - despite its success - foundational principles for quantum Mechanics still remain unknown. Will future developments in Quantum Mechanics reveal such principles in coming years? Three distinguished scholars will consider the future of Quantum Mechanics, and address topics such as quantum non locality, entanglement, and a possible sub-quantum mechanics.

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Info

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Participation

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Profile

GIANCARLO GHIRARDI

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Giancarlo Ghirardi (born October 28, 1935) is an Italian physicist and Emeritus professor of theoretical physics at the University of Trieste. He is well known for the Ghirardi-Rimini-Weber theory (GRW), which he proposed in 1985 together with Alberto Rimini and Tullio Weber, and for his contributions to the foundations of quantum mechanics. His research interests relate to variety of topics of theoretical physics; focussing since 1983 mainly on the foundations of quantum mechanics. Ghirardi is member of the editorial board of Foundations of Physics and formerly of Studies in History and Philosophy of Modern Science. He is president of the Italian Society for the Foundations of Physics, of which he is one of the founding members. The President of the Province of Trieste, Maria Teresa Bassa Poropat, conferred the 'Sigillo della Provincia di Trieste' to GianCarlo Ghirardi for research and teaching, for his commitment to the promotion and development of physics in Trieste and for his intense and fruitful activity as the author of popular books and scientific publications.

VIDEOS WITH GIANCARLO GHIRARDI

VIDEO

PHYSICS
Probing the Superposition Principle at the Macroscopic Level

PAPERS FROM GIANCARLO GHIRARDI

Paper
EmQM13 – Probing the Superposition Principle at the Macroscopic Level

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Profile

GREGOR WEIHS

University of Innsbruck, AT

Gregor Weihs is Professor of Photonics and Head of the Institute for Experimental Physics at the University of Innsbruck and an Associate of the University of Waterloo's Institute for Quantum Computing. While being on leave from his position in Vienna he spent two and a half years as Consulting Assistant Professor at Stanford University collaborating with the group of Yoshihisa Yamamoto (now at RIKEN) and Assistant Professor of Research at Tokyo University working on semiconductor quantum optics with Yasuhiko Arakawa's group. Gregor Weihs was DOC-fellow of the Austrian Academy of Sciences; he won the Appreciation Award of the Austrian Ministry of Science and Transport and the Loschmidt-Prize of the Chemical-Physical Society in Vienna. In 2007 he was awarded the Canada Research Chair in Quantum Photonics and in 2010 a Starting Grant by the European Research Council. In 2011 he was elected into the Austrian Academy of Sciences as a member of the Young Academy. His memberships include the Chemical-Physical, Austrian and American Physical Societies, the Canadian Association of Physicists, as well as the Optical Society of America. He is a fellow of the QIP program of the Canadian Institute for Advanced Research, and in addition currently holds grants from the European Research Council (ERC), and the Austrian Science Fund (FWF). In his research interests include fundamental physics both experimental and theoretical, quantum and semiconductor optics and quantum information. He currently focuses on novel sources of entangled photon pairs from nonlinear waveguides, via strong coupling in semiconductor microcavities, and from semiconductor quantum dots. He further does research is in quantum communication and the foundations of physics.

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Multipath Interference Tests of Quantum Mechanics

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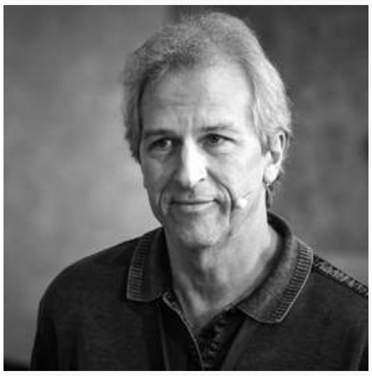
HANS-THOMAS ELZE

Dipartimento di Fisica “Enrico Fermi”, Università di Pisa



Hans-Thomas Elze is a theoretical physicist. - Phd at University of Frankfurt (1985), followed by positions in Berkeley, Helsinki, and 3 years spent at CERN. Professorships in Bremen, Regensburg, and Tucson (Arizona). Professor at Brazil’s renowned Universidade Federal do Rio de Janeiro (1997-2004).

Affiliated with Universita di Pisa (since 2004). - Several Fellowships, notably Heisenberg Fellow Award (German science foundation, DFG) for quantum transport theory in gauge theories. Organizer of biannual DICE (foundations of physics) conferences in Italy since 2002.

Present interests include: entanglement entropy, decoherence, emergence of quantum mechanics.

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Participation

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Profile

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Helmut Rauch (born 22 January 1939 in Krems an der Donau, Lower Austria) is an Austrian physicist. He is specially known for his pioneering experiments on neutron interference. Rauch studied Physics at Vienna University of Technology and worked at Atominstitut Vienna. He has also been affiliated with Forschungszentrum Jülich and Institut Laue-Langevin in Grenoble. In 1974, Rauch, together with Ulrich Bonse and Wolfgang Treimer, demonstrated the first matter wave interference of Neutrons. This demonstrated the wave-like nature of neutrons for the first time and was another experimental proof that not only photons can be described by waves, but also massive particles. Further they demonstrated the fundamental symmetry of spin 1/2 particles under rotations.

VIDEOS WITH HELMUT RAUCH

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Ignorance governs quantum experiments

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Non-Locality and Destructive Interference of Matter Waves

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Participation

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Profile

HOWARD WISEMAN

Centre for Quantum Dynamics, Griffith University

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Howard Mark Wiseman (born 19 June 1968) is a theoretical quantum physicist notable for his work on quantum feedback control, quantum measurements, quantum information, open quantum systems, the many interacting worlds interpretation of quantum mechanics, and other fundamental issues in quantum mechanics. Wiseman was born in Brisbane, Australia and received his B.Sc.(Hons) in Physics from the University of Queensland in 1991.

He completed his PhD in physics under Gerard J. Milburn at the University of Queensland in 1994, with a thesis entitled Quantum Trajectories and Feedback. After his PhD, Wiseman undertook a postdoc under Dan Walls at the University of Auckland. From 1996 to 2009 he held Australian Research Council (ARC) research fellowships. He is currently a Physics Professor at Griffith University, where he is the Director of the Centre for Quantum Dynamics. He is also an Executive Node Manager in the Centre for Quantum Computation and Communication Technology, an ARC Centre of Excellence. His awards include the Bragg Medal of the Australian Institute of Physics, the Pawsey Medal of the Australian Academy of Science and the Malcolm Macintosh Medal, one of the Prime Minister's Prizes for Science. He is a Fellow of the Australian Academy of Science, and a Fellow of the American Physical Society.

(source: Wikipedia)

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Paper
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Metascience 2019 Symposium - The Emerging Field of Research on the Scientific Process

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Profile

JAN WALLECZEK

Phenoscience Laboratories

Jan Walleczek Ph.D. is Director of the Fetzer Franklin Fund, and a Trustee of the John E. Fetzer Memorial Trust. He lives in Berlin, Germany, where he founded Phenoscience Laboratories. Previously he was Director of the Bioelectromagnetics Laboratory at Stanford University Medical School, Palo Alto, California. Jan Walleczek studied biology at the University of Innsbruck in Austria, followed by doctoral work at the Max-Planck-Institute for Molecular Genetics in Berlin, and post-doctoral work at the Research Medicine and Radiation Biophysics Division of the Lawrence Berkeley National Laboratory, University of California at Berkeley.

His research interests are diverse, and his scientific publications cover the fields of biology, chemistry, engineering, and physics. His work focuses on the foundations of quantum mechanics and the application to living systems of concepts such as quantum coherence, emergent dynamics, and the flow of information, a long-standing interest that he summarized as an edited volume for Cambridge University press titled “Self-organized biological dynamics and nonlinear control”. In addition to metascience and advanced research design, his professional interests include the philosophy and the foundations of science.

VIDEOS WITH JAN WALLECZEK

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Profile

JEFF TOLLAKSEN

Institute for Quantum Studies and Schmid College of Science and Technology, Chapman University

Jeff Tollaksen is a Professor of Physics and Director of the Center for Excellence in Quantum Studies at Chapman University. He received his BA in physics from MIT. He later attended Boston University where he earned a MA and PhD in theoretical physics.

Before teaching at Chapman University, Tollaksen worked in the School of Computational Science at George Mason University. He has published over a dozen articles in various scientific journals and has conducted research via five grants on which he is the prime investigator.

(source: Chapman University)

VIDEOS WITH JEFF TOLLAKSEN

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Paper
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SPEAKER
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Austrian Academy of Sciences - Festsaal

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Physics

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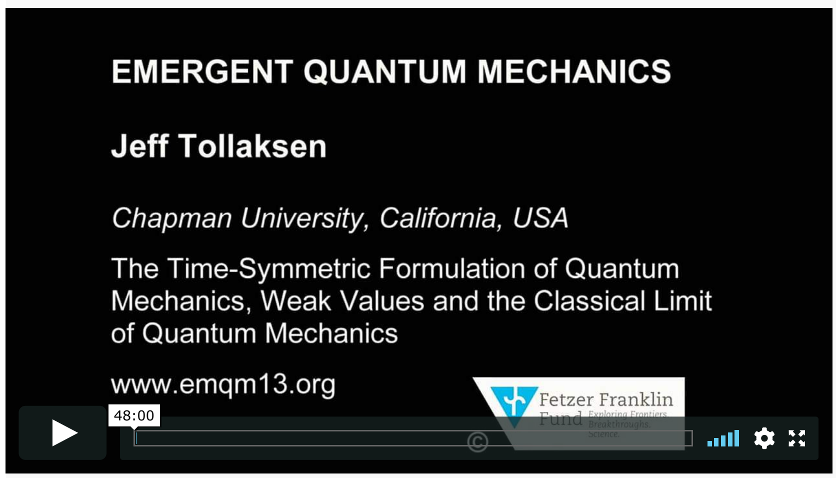
THE TIME-SYMMETRIC FORMULATION OF QUANTUM MECHANICS, WEAK VALUES AND THE CLASSICAL LIMIT OF QUANTUM MECHANICS

Jeff Tollaksen Austrian Academy of Sciences – Festsaal



The two-state vector formalism provides a complete description of pre- and post-selected quantum systems and has uncovered a host of new quantum phenomena which were previously hidden. The most important feature is that any weak coupling to a pre- and post-selected system is effectively a coupling to a "weak value" which is given by a simple expression depending on the two-state vector. In particular, weak values, are the outcomes of so called "weak measurements" which have recently become a very powerful tool for ultra-sensitive measurements. Using weak values, I will show that the classical limit of quantum mechanics is a far more complicated issue; it is in fact dramatically more involved and it requires a complete revision of all our intuitions. The revised intuitions can then serve as a guide to finding novel quantum effects.

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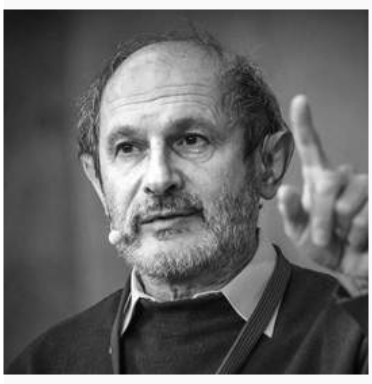

CURRICULUM VITAE
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2008 private professor (Eötvös University, Budapest)
2007 habilitated doctor (Eötvös University, Budapest)
2000 Doctor of Academy (Hungarian Academy of Sciences)
1987 "Candidate" degree (Hungarian Academy of Sciences)
1976 Ph.D. (Eötvös University, Budapest)
1973 M.Sc. with Distinction (Eötvös University, Budapest)
- Awards, Honours, memberships
2014 Member of Editorial Board, International Journal of Quantum Foundations
2012 Prize of the Academy (Hungarian Academy of Sciences)
2011 Management Committee, COST Action Fundamental Problems in Quantum Physics
2008 Member of Editorial Advisory Board, The Open Nuclear & Particle Physics Journal
2008 Lady Davies Visiting Professorship (Technion, Israel)
1999 Member of Institute for Advanced Study (Berlin, Wissenschaftskolleg)
1997 Visiting Professor (QMW College, London University)
- Employment
2000 scientific advisor, High Energy Physics Department
1988 senior research associate, High Energy Physics Department
1979 research associate, High Energy Physics Department
1976 co-worker, Computer Technics Department,
1973 postgraduate position, High Energy Physics Department
- Research Interests
Foundations of quantum theory -- emergence of classicality
Quantum information theory
Open quantum systems -- master equations, stochastic trajectories
Thermodynamics -- Riemann-geometric methods, finite-time-processes
Cosmology -- viscous early universe
High energy physics -- 40GeV hadron-nucleus experiment
Particle physics -- multiparticle production, phenomenology
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103 refereed papers +35 book/proceedings contributions +2 books
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62 conference talks +55 seminars
- Referee for Physical Review A, B, E, Letters, Physics Letters A, ... (>150 times)
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1997 Imperial College, London
1996 Queen Mary and Westfield College, London
1993 Geneva University, Geneva
1991 Niels Bohr Institute, Copenhagen
1990 International Centre for Theoretical Physics, Triest
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2004-6-8-10-12-14 co-organizer of Intl. Workshops DICE (Tuscany)
1993 co-organizer of Intl. Workshop Stochastic Evolution of Quantum States (Budapest)

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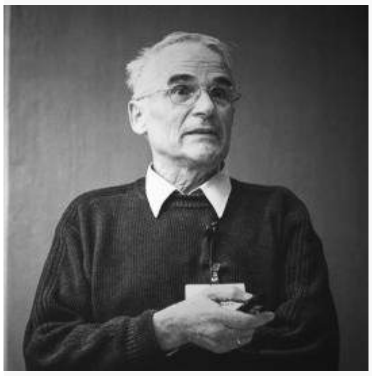

Manfried Faber, geboren 1947 in Innsbruck, ist Professor am Atominstitut der TU Wien. Sein Forschungsgebiet ist das der „fundamentalen Wechselwirkungen“, insbesondere der starken Wechselwirkung. Diese Wechselwirkung hält die Atomkerne im Innersten zusammen und wird durch die Theorie der „Quantenchromodynamik“ (QCD) beschrieben. Prof. Faber hält Vorlesungen und betreut Projektarbeiten, Diplomarbeiten und Dissertationen zu diesem Thema.
Zu den Stationen seines beruflichen und akademischen Werdegangs gehören unter anderem der Vorsitz des „Universitätslehrverbandes der TU Wien“, sowie des „Verbandes des wissenschaftlichen und künstlerischen Personals der österreichischen Universitäten“. Er war Mitglied des „österreichischen Rates für Wissenschaft und Forschung“, sowie des „Kuratoriums des Fonds zur Förderung der wissenschaftlichen Forschung“. Als Gastprofessor bzw. Gastdozent lehrte Prof. Faber auch an der Universität Innsbruck, der Universität Linz und der Universität für Bodenkultur.

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EMQM13 – CAUSALITY AND LOCAL DETERMINISM VERSUS QUANTUM NONLOCALITY

Marian Kupczynski, Department of Computer Science, Université du Québec, CA

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Abstract

Quantum theory (QT), giving accurate predictions for the statistical distribution of outcomes obtained in physical experiments, is unable to predict which outcome and when will be observed. In spite of this it is often claimed that QT provides the most complete description of individual physical systems and that the outcomes of quantum measurements are produced in irreducibly random way.

According to statistical interpretation of (SI), which is free of paradoxes, QT does not provide the complete description of individual physical systems and might be an emerging theory from some more detailed deeper level description of the physical phenomena. In particular long range correlations predicted by QT for EPR type experiments and confirmed in spin polarization correlation experiments (SPCE) seem to "cry for explanation". Searching for the intuitive explanation of these correlations Bell analyzed local realistic and local stochastic hidden variable models and found that these models led to inequalities (B-CHSH) which were violated by some QT predictions. Bell believed that no other local models were possible therefore the experimentally confirmed violation of B-CHSH has been incorrectly interpreted as a mysterious non locality of Nature and paraphrased sometimes as: "two perfectly random dices tossed in two far away locations produce perfectly correlated outcomes". Of course photons are not dices, correlations are not perfect and the confusion came from imprecise terminology and from the lack of understanding of the true meaning of probabilistic models used in various proofs of Bell and CHSH theorems.

The main assumption in these models was that all the results of different experiments performed in incompatible experimental settings can be always described using a unique probability space and some joint probability distribution. Several authors pointed out that this assumption was very restrictive and that it was inconsistent with the experimental protocols used in SPCE and this is the only reason why B-CHSH were violated. It seems also impossible that strongly correlated outcomes in SPCE are obtained in irreducibly random way because in this case the memory of correlations between physical signals created at the source would be destroyed. Therefore the probabilistic description of SPCE, consistent with QT predictions, has to depend explicitly on the context of each experiment. It has also to be deterministic in the sense that the outcome is determined by the supplementary parameters describing both a physical signal and an instrument in the moment of the measurement.

In the first part of my talk I will explain in some detail why B-CHSC can be violated and why their violation gives additional arguments that QT can be interpreted as an emerging theory respecting the causality and the local determinism on the microscopic level. Without the irreducible randomness on the microscopic level it is much easier to understand the existence of determinism and causality observed in natural phenomena not only in classical physics. If QT is emerging theory then in various time-series of experimental data there exist perhaps some fine structures not predicted before. If we find them we may even conclude that QT is not predictably complete. In the second part of my talk I will review some statistical tools which could help to achieve this goal.

M. Kupczynski, Entanglement and quantum nonlocality demystified, – AIP Conf.Proc. 1508.253 (2012).
M. Kupczynski, Time Series, Stochastic Processes and Completeness ..., – AIP Conf.Proc. 1327.394 (2011).
M. Kupczynski, Is quantum theory predictably complete?, Phys. Scr. T135, 014005 (2009)
Easy access from : http://w4.uqo.ca/kupcma01/Bell.htm

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• 1971 M.Sc. (physics), University of Warsaw, Poland.

• 1981 Ph.D. (theoretical physics), University of Warsaw, Poland.

Research interests

• Foundations of quantum mechanics. Quantum information. Violation of Bell inequalities and completeness of quantum mechanics.

• High energy scattering. Possibility of the violation of the optical theorem in spite of the unitarity of S matrix.

• Search for the experimental evidence of the violation of the optical theorem in high energy hadron-hadron scattering in LHC.

• Statistical analysis of the experimental data. Non parametric compatibility tests (purity tests). Search for the fine structures

in time- series of data.

• Predictions of the quark model for the scattering of polarized initial beams. (Ph.D. Thesis and related publications).

• Group theory. Contractions of Lie groups and their representations. (M.Sc. Thesis and related publications)

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MARKUS ARNDT

Faculty of Physics and QuNaBioS, University of Vienna,

Download vita

Markus Arndt (* 14. September 1965 in Unkel) ist ein deutscher Physiker und Professor für Quantennanophysik an der Universität Wien.
Markus Arndt studierte von 1985 bis 1990 Physik in Bonn und München. Es folgten von 1991 bis 1994 Doktoratsstudien am Max-Planck-Institut für Quantenoptik in Garching; das Thema der Dissertation lautete Optical and magneto-optical spectroscopy of metal atoms in liquid and solid He-4. Von 1994 bis 1995 war Arndt wissenschaftlicher Mitarbeiter am Max-Planck-Institut für Quantenoptik, von 1999 bis 2002 Universitätsassistent am Institut für Experimentalphysik der Universität Wien, ebenda erfolgte 2002 seine Habilitation. Ab September 2004 war er Vertragsprofessor für Quantennanophysik an der Universität Wien. 2008 wurde er Universitätsprofessor für Quantennanophysik an der Fakultät für Physik der Universität Wien.
Markus Arndt ist verheiratet und hat zwei Söhne.

Im Jahr 2000 erhielt er den Erich-Schmid-Preis der österreichischen Akademie der Wissenschaften (ÖAW), gemeinsam mit G. Springholz, sowie den Fritz-Kohlrausch Preis der Österreichischen Physikalischen Gesellschaft (ÖPG). Im Jahr 2001 wurde er mit dem START-Preis des Fonds zur Förderung der wissenschaftlichen Forschung (FWF) ausgezeichnet, 2008 mit dem FWF Wittgensteinpreis Wittgensteinpreis. 2012 warb er einen Advanced Grant des Europäischen Forschungsrats (ERC) ein [3]. Im Jahr 2013 wurde ihm der Preis der Stadt Wien für Naturwissenschaften zuerkannt. 2014 wurde er zum korrespondierenden Mitglied im Inland der mathematisch-naturwissenschaftlichen Klasse der Österreichischen Akademie der Wissenschaften gewählt.

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Profile

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Masanao Ozawa (jap. 小澤 正直, Ozawa Masanao ; * 1950) ist ein japanischer Mathematiker und Physiker der Universität Nagoya. Er erlangte durch Arbeiten zur heisenbergschen Unschärferelation internationale Aufmerksamkeit.
Ozawa promovierte an der Tokyo Kogyo Daigaku und ist heute Professor an der Graduiertenschule für Informatik an der Universität Nagoya. Davor war er Professor in Nagoya und an der Universität Tohoku. Er befasst sich insbesondere mit Quanteninformationstheorie, dem Messprozess in der Quantenmechanik und offenen Quantensystemen.
Seine Theorie konnte 2012 in einer Gruppe am Atominstitut der Technischen Universität Wien um Yuji Hasegawa durch Experimente mit Neutronenspins[2] und durch Versuche eines Teams der University of Toronto um Aephraim Steinberg mit polarisierten Photonen bestätigt werden.

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Profile

MAURICE DE GOSSON

University of Vienna, Faculty of Mathematics, NuHAG

Maurice A. de Gosson also known as Maurice Alexis de Gosson de Varennes is an Austrian mathematician and mathematical physicist, born in 1948 in Berlin. He is currently a Senior Researcher at the Numerical Harmonic Analysis Group (NuHAG) of the University of Vienna.

After completing his PhD in microlocal analysis at the University of Nice in 1978 under the supervision of Jacques Chazarain, de Gosson soon became fascinated by Jean Leray's Lagrangian analysis. Under Leray's tutorship de Gosson completed a Habilitation à Diriger des Recherches en Mathématiques at the University of Paris 6 (1992). During this period he specialized in the study of the Leray-Maslov index and in the theory of the metaplectic group, and their applications to mathematical physics. In 1998 de Gosson met Basil Hiley, who triggered his interest in conceptual question in quantum mechanics. Basil Hiley wrote a foreword to de Gosson's book The Principles of Newtonian and Quantum Mechanics (Imperial College Press, London). After having spent several years in Sweden as Associate Professor and Professor in Sweden, de Gosson was appointed in 2006 at the Numerical Harmonic Analysis Group of the University of Vienna, created by Hans Georg Feichtinger (see www.nuhag.eu). He currently works in symplectic methods in harmonic analysis, and on conceptual questions in quantum mechanics, often in collaboration with Basil Hiley.

Maurice de Gosson has held longer visiting positions at Yale University, University of Colorado in Boulder (Ulam Visiting Professor), University of Potsdam, Albert-Einstein-Institut (Golm), Max-Planck-Institut für Mathematik (Bonn), Université Paul Sabatier (Toulouse), Jacobs Universität (Bremen).

Maurice de Gosson was the first to prove that Mikhail Gromov's symplectic non-squeezing theorem (also called „the Principle of the Symplectic Camel") allowed the derivation of a classical uncertainty principle formally totally similar to the Robertson-Schrödinger uncertainty relations (i.e. the Heisenberg inequalities in a stronger form where the covariances are taken into account). This rather unexpected result was discussed in the media.

In 2004/2005, de Gosson showed that Gromov's non-squeezing theorem allows a coarse graining of phase space by symplectic quantum cells, each described by a mean momentum and a mean position. The cell is invariant under canonical transformations. De Gosson called such a quantum cell a quantum blob: *"The quantum blob is the image of a phase space ball with radius by a (linear) symplectic transformation"* and *"Quantum blobs are the smallest phase space units of phase space compatible with the uncertainty principle of quantum mechanics and having the symplectic group as group of symmetries. Quantum blobs are in a bijective correspondence with the squeezed coherent states from standard quantum mechanics, of which they are a phase space picture."*

Their invariance property distinguishes de Gosson's quantum blobs from the "quantum cells" known in thermodynamics, which are units of phase space with a volume of the size of Planck's constant h to the power of 3.

De Gosson's notion of quantum blobs has given rise to a proposal for a new formulation of quantum mechanics, which is derived from postulates on quantum-blob-related limits to the extent and localization of quantum particles in phase space; this proposal is strengthened by the development of a phase space approach that applies to both quantum and classical physics, where a quantum-like evolution law for observables can be recovered from the classical Hamiltonian in a non-commutative phase space, where x and p are (non-commutative) c-numbers, not operators.

(source: Wikipedia)

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I am currently engaged in research projects in several fields. These include:

Statistical Physics: Foundational issues, non-equilibrium methods, generalized statistics of Renyi and Tsallis, applications to econophysics, multifractals.

Quantum Mechanics: Feynman's path integral, geometric phases, foundations, 't Hooft's quantization proposal, supersymmetric QM,.

Quantum Field Theory and Particle Physics: Functional integral, particle oscillations and mixing, defect mediated phase transitions, topological defects.

Education

Ph.D. in Theoretical Physics, DAMTP University of Cambridge, UK

M.Sc. in Theoretical Physics, Mathematical Tripos, Part III, DAMTP University of Cambridge, UK

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2001 MSc Master of Science - Particle Physics Royal Holloway

1980 BSc Hons Bachelor of Science (Honours) - Physics University of East Anglia

(source: University College London)

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SABINE HOSSENFELDER

Frankfurt Institute for Advanced Studies (FIAS), DE

Sabine Hossenfelder received her PhD from the University of Frankfurt, Germany, in 2003. She worked as a postdoc at the University of Arizona, Tucson, and later at the University of California, Santa Barbara, and the Perimeter Institute in Waterloo, Canada. Sabine joined Nordita in September 2009.

Sabine's main research interest is physics beyond the standard model, with a special emphasis on the phenomenology of quantum gravity. This still young research field brings together experimentalists and theorists and connects many different areas, from cosmology and astrophysics over neutrino physics to particle colliders and high precision measurements. Her contributions are focused on the role of Lorentz-invariance and locality, which might be altered in the fundamental to-be-found theory of quantum gravity and be accessible to experiment.

Sabine has collaborators at Perimeter Institute in Canada, at the University of Sussex, at SISSA in Trieste, and the MPI in Potsdam, Germany. At Nordita, she has organized a workshop on "Experimental Search for Quantum Gravity" in summer 2010 that was well attended by Nordic and international participants.

VIDEOS WITH SABINE HOSSENFELDER

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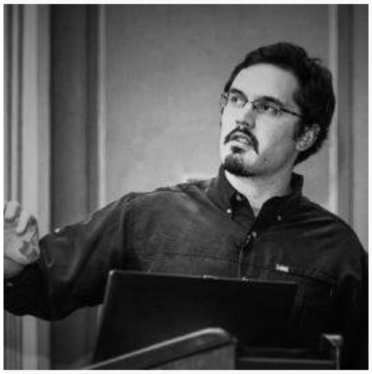

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Paper
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EMQM13 – WHERE IS QUANTUM THEORY HEADED?

Stephen Adler, Institute for Advanced Study, Princeton, USA

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Abstract

Public talk at the EmQM13 conference opening event on “The Future of Quantum Mechanics”.

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STEPHEN ADLER

Institute for Advanced Study, Princeton, USA

Stephen Adler (b. 1939 in New York City) is an American physicist specializing in elementary particles and field theory. He received an A.B. degree at Harvard University in 1961 and a Ph.D. from Princeton University in 1964. He became a member of the Institute for Advanced Study in 1966, becoming a full Professor of Theoretical Physics in 1969, and was named "New Jersey Albert Einstein Professor" at the institute in 1979. He has won the J. J. Sakurai Prize from the American Physical Society in 1988, and the Dirac Medal of the International Centre for Theoretical Physics in 1998, among other awards. Adler's seminal papers on high energy neutrino processes, current algebras, soft pion theorems, sum rules, and perturbation theory anomalies helped lay the foundations for the current standard model of elementary particle physics.

Princeton University, Ph.D. 1964; Harvard University, Junior Fellow, Harvard Society of Fellows, 1964-66; California Institute of Technology, Research Associate 1966; Princeton University, Visiting Lecturer 1969; Institute for Advanced Study, Member 1966-69, New Jersey Albert Einstein Professor 1979-2003, Professor 1969-2010, Professor Emeritus 2010-; American Academy of Arts and Sciences, Fellow; American Association for the Advancement of Science, Fellow; American Physical Society, Fellow; National Academy of Sciences, Member; American Physical Society, J. J. Sakurai Prize 1988; International Centre for Theoretical Physics, Dirac Prize and Medal 1998

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Paper
EmQM13 – Where is quantum theory headed?

Presentation
EmQM13 – Incorporating Gravity Into Trace Dynamics: the Induced Gravitational Action

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THEO NIEUWENHUIZEN

Faculteit der Natuurwetenschappen, Universiteit van Amsterdam (UvA), NL

Theo Nieuwenhuizen concluded his master's exam cum laude in 1979, under the supervision of Professor Gerard 't Hooft, Nobel Prize Laureate and a member of the IIP's International Advisory Council. During the time studying for his PhD degree in Mathematics and Physics, he developed the thesis "Analytic methods and exact solutions for one-dimensional random systems". Nieuwenhuizen's work covers a wide variety of topics in theoretical physics, including a recently published solution to the quantum measurement problem.

He has previously worked in Brazil to organise a summer school in João Pessoa in 2012. Nieuwenhuizen now plans to visit Natal in September 2014 to start organising a school on "Quantum Foundations", to be held at the IIP in 2016.

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Participation

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Profile

WERNER HOFER

Newcastle University, UK

Werner A. Hofer was born in Salzburg, Austria. He is a Royal Society University Research Fellow (since 2003) and Professor of Chemistry and Physics in the Surface Science Research Centre of the University of Liverpool. He holds a Ph.D. (1999) from the Vienna University of Technology. Before joining the University of Liverpool in 2002, he held Research Fellow positions at University College London. Dr. Hofer was appointed as an Associate of CIAR's Nanoelectronics Program in 2007.Dr. Hofer's research is focused mainly on high-precision methods to simulate electron transport within a scanning tunneling microscope (STM). Initially, the application of perturbation theory centered on the modification of images due to different tip structures and atomic displacement in the close distance regime between surface and STM tip. He has shown that the method can be applied to practically all experimental situations, where STMs are used to analyze the geometric or electronic structure of metals, semiconductors, and molecules adsorbed on a conducting substrates. Recently, he has developed a scattering approach for the tunneling problem, which overcomes the problems related to perturbation theory, in particular the low-bias limit, imposed by a perturbative treatment.

"Werner Hofer has a foot in both camps. He's an expert on the conventional theory behind the scanning tunnelling microscope, but maybe at heart he's a dissident." - Caroline Thompson

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Bill Poirier

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YUJI HASEGAWA

Atominstitut, TU Vienna, AT

Yuji Hasegawa is working right now at the Atominstitut der Österreichischen Universitäten, Wien. His group is engaged in quantum optical experiments with neutrons. He studied Applied Physics at the University of Tokyo, Japan and then moved in Wien between 1991 and 1992 as exchange student between TU Wien and the University of Tokyo. During his exchange in Wien, he joined the group of Prof. Rauch´s neutron interferometer at the Atominstitut.
Coming back to Tokyo, he ended his Ph.D. about interference experiments using high-energy photons, x-rays from synchrotron radiation, and neutrons.
He became a Postdoc at the University of Tokyo and constructed a precise neutron optics (PNO) beam-line at the JRR-3M, Japan Atomic Energy Research Institute (JAERI), Tokai, Japan.

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Participation

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Profile

YVES COUDER

Laboratoire Matière et Systèmes Complexes (MSC) Université Paris, FR

Yves Couder travaille au Laboratoire Matière et Systèmes complexes de l'Université Paris Diderot. Après une formation en physique de la matière condensée, il s'est orienté vers la physique non-linéaire sous ses aspects divers ; chaos spatio-temporel, turbulence en 2 et 3 dimensions et morphogénèse. Dans ce dernier domaine il s'est intéressé aux formes résultant de la croissance soit dans divers systèmes physiques, soit en biologie végétale. Ses travaux récents sont consacrés à la dualité onde-particule à l'échelle macroscopique.

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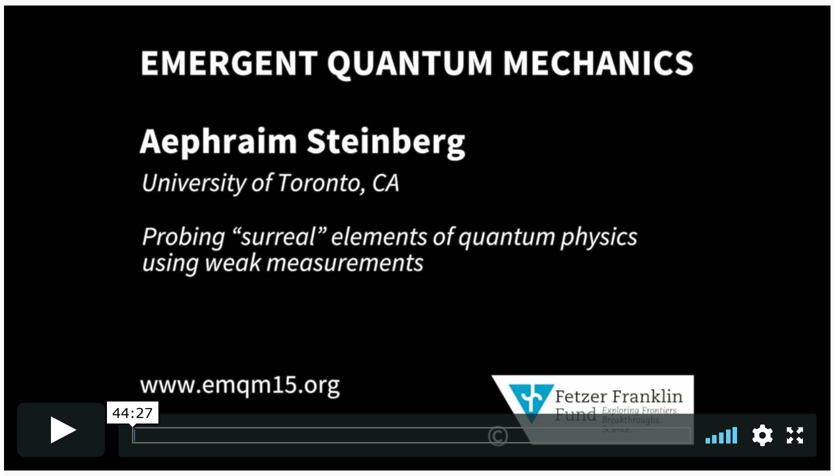
PROBING "SURREAL" ELEMENTS OF QUANTUM PHYSICS USING WEAK MEASUREMENTS

Aephraim Steinberg Vienna University of Technology



While many authors write about the strange features of quantum mechanics and its various interpretations, Englert, Scully, Süssmann, and Walther (ESSW) went further, arguing that the description afforded by the Bohmian picture was not merely strange but "surreal."

The de Broglie-Bohm model of quantum mechanics is famously realist and deterministic, providing each particle with a definite trajectory. ESSW studied a case in which they argued that these trajectories contradicted clearly observable properties of the system, concluding that rather than describing reality, such trajectories were "surreal." In collaboration with Wiseman, who proposed a technique for directly observing quantum trajectories using weak measurement, we have now implemented a scenario based on ESSW's, and I will present experimentally extracted surreal trajectories. We use our observations to demonstrate the intrinsic nonlocality of the Bohm model, and show how a proper consideration of these nonlocal effects resolves any seeming paradoxes.

I will go on to describe two other experiments using weak measurement to expose surprising or surreal features of quantum mechanics. In one, due to the striking effects of "post-selective" measurements, a measurement of photon number can yield a value much larger than one, even when it is carried out on a single photon. I will say a few words about possible practical applications of this "weak value amplification" scheme. In another experiment, still ongoing, I will explain how it should be possible to measure "where a particle has been" as it tunnels through a classically forbidden region – and our expectation that it will make it from one side of the barrier to the other without spending any significant time in the middle.

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AEPHRAIM STEINBERG

CQIQC, University of Toronto

Aephraim Steinberg is a Professor in the Department of Physics at the University of Toronto. He is also a founding member of Toronto's Institute for Optical Sciences, a member and past director of the Centre for Quantum Information and Quantum Control (CQIQC), an affiliate member of the Perimeter Institute for Theoretical Physics and a principal investigator in Photonics Research Ontario, the Canadian Institute for Photonic Innovations, and QuantumWorks.

Dr. Steinberg received his undergraduate degree from Yale University in 1988 and his Ph.D. from the University of California at Berkeley in 1994. He then held post-doctoral fellowships at the Université de Paris VI and the U.S. National Institute of Standards and Technology before moving to Toronto in 1996. He has been a guest professor at the University of Vienna; the Institut d'Optique Théorique et Appliquée in Orsay, France; and the University of Queensland in Australia.

In 2006, he received the Canadian Association of Physicists Herzberg Medal and the Rutherford Medal in Physics from the Royal Society of Canada. In 2007, he received a Steacie Fellowship from NSERC, and a McLean Fellowship (Connaught Foundation, University of Toronto). He is a Fellow of the Institute of Physics (UK), the American Physical Society, and the Optical Society of America.

He joined CIFAR's *Quantum Information Science* Program in 2003.

Dr. Steinberg's interests lie in fundamental quantum-mechanical phenomena and the control & characterization of the quantum states of systems ranging from laser-cooled atoms to individual photons. His experimental program is two-pronged, using both nonclassical two-photon interference and laser-cooled atoms to study issues such as quantum information & computation, decoherence and the quantum-classical boundary, tunneling times, weak measurement & retrodiction in quantum mechanics, and the control and characterization of novel quantum states.

(source: University of Toronto)

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ANA MARÍA CETTO

Universidad Nacional Autónoma de México, MX

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Prof. Ana María Cetto, Research professor of the Institute of Physics and lecturer at the Faculty of Sciences, Universidad Nacional Autónoma de México. Ana María Cetto is a full-time research Professor at the Institute of Physics, and lecturer at the Faculty of Sciences, Universidad Nacional Autónoma de México (UNAM). She holds an M.A. in Biophysics from Harvard University and a M.S c and Ph.D in Physics from UNAM. Her main field of research is theoretical physics, with emphasis on the foundations of quantam mechanics, where she has contributed substantially to the development of stochastic electrodynamics. She is co-author of "The Quantum Dice" (Kluwer, 1996). Prof. Cetto is the former Dean of the Faculty of Sciences, and former head of the Theoretical Physics Department at the Institute of Physics. She chaired the project for the Museum on Light (UNAM), inaugurated in 1996. She served as consultant for the UNESCO World Conference of Science (1999). From 2003 to 2010 she served as Deputy Director General of the International Atomic Energy Agency (Nobel Peace Prize 2005), where she headed the Department of Technical Cooperation. She is founding President of LATINDEX, online information system for Ibero-American and Caribbean scholary journals. Prof Cetto has held honorary positions in a number of international organisations, such as the Executive Boards of Interciencia Association, Third World Organisation for Women in Science (TWOWS, Co-founder) and International Council for Science (ICSU), the Board of Trustees of International Foundation for Science (IFS), the Governing Board of United Nations University (UNU), the Council of International Network of Engineers and Scientists (INES) and the Executive Committee of Pugwash Conferences (Nobel Peace Prize 1995). She was appointed Mexico's Woman of the Year in 2003.

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TWO-ELECTRON SYSTEM CORRELATED BY THE ZERO-POINT FIELD: PHYSICAL EXPLANATION FOR THE SPIN-STATISTICS CONNECTION

Ana María Cetto Vienna University of Technology

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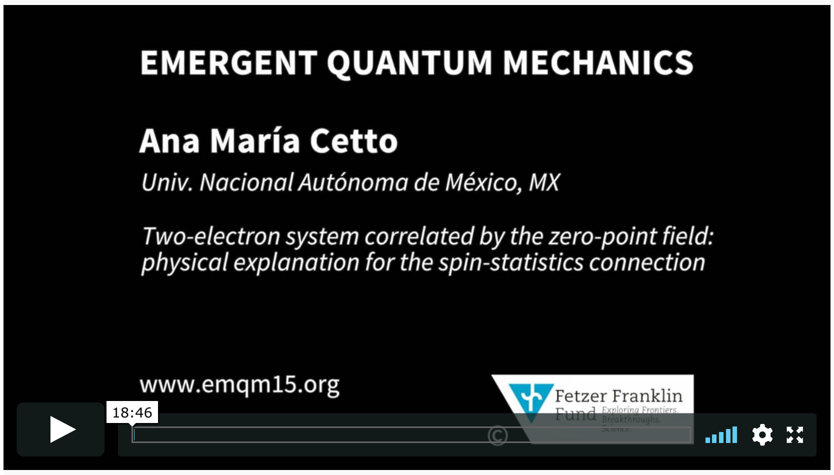

Which is the physical agent behind the electronic structure of atoms and the antisymmetry of the electron state vectors?
With the purpose to find an answer to this key question, we analyze the possible stationary states of a system of noninteracting particles, using the tools of stochastic electrodynamics. In previous work, the resonant response of two particles to common modes of the random zero-point field has been shown to lead to the nonfactorizability of the composite state vector. Here we extend the analysis to a system of two atomic electrons with spin. For the electrons to constitute a single system, a correlation must be established between their dynamical variables. This happens in particular if common zero-point field modes link either the orbital or the spin states (or both). For such correlations to exist, the total (orbital plus spin) state vectors must be antisymmetric. States in which both electrons are in the same orbital and spinorial state, are excluded because of the absence of a correlating field mode. The corollary is that due consideration of the vacuum field in first quantization leads to the correct statistics for a system of electrons.

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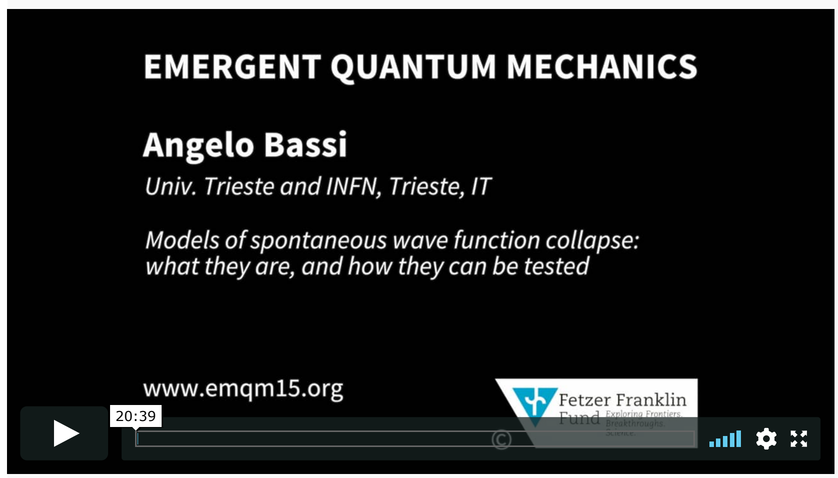
MODELS OF SPONTANEOUS WAVE FUNCTION COLLAPSE: WHAT THEY ARE, AND HOW THEY CAN BE TESTED

Angelo Bassi



There are few proposals, which explicitly allow for (experimentally testable) deviations from standard quantum theory. Models of spontaneous wave function collapse (collapse models) are among the most-widely studied proposals of this kind. The Schrödinger equation is modified by including nonlinear and stochastic terms, which describe the collapse of the wave function in space. These spontaneous collapses are “rare” for microscopic systems, hence their quantum properties are left almost unaltered. On the other hand, collapses become more and more frequent, the larger the object, to the point that macroscopic superpositions are rapidly suppressed. I will briefly review the main features of collapse models. Next I will present an update of the most promising experimental tests, ranging from cosmological observations, to matter-wave interferometry, to optomechanics, to spectroscopy.

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Participation

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Profile

ANGELO BASSI

Department of Physics, University of Trieste, IT

Angelo Bassi was born in Udine (Italy) in 1973. He was awarded the degree in Physics (Summa cum laude) at the University of Trieste in 1998 and the Ph.D. in Physics in 2001. Subsequently he was Post Doctoral Fellow and Visiting Scientist at the ICTP in Trieste (2002/04) and Marie-Curie Fellow at the University Ludwig-Maximillian of Munich (2004/06). In December 2006 he became staff member of the Department of Physics of the University of Trieste.

He published about 50 articles in international Journals, among which: 1 Science, 4 PRL, 1 Rev. Mod. Phys, 1 Phys. Rept. He is referee for the APS and IOP journals, and for the American NSF. He is co-organizer of 9 international conferences, workshops, schools on Quantum Mechanics and related topics. He was invited speaker at 25 international conferences and schools. He was guest editor of the special issue of Journal of Physics A: "The Quantum Universe" (2007). He is Chair of the COST Action Fundamental Problems in Quantum Physics

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TRADING DRIFT AND FLUCTUATIONS IN ENTROPIC DYNAMICS: A NEW SYMMETRY FOR QUANTUM MECHANICS

Ariel Caticha Vienna University of Technology

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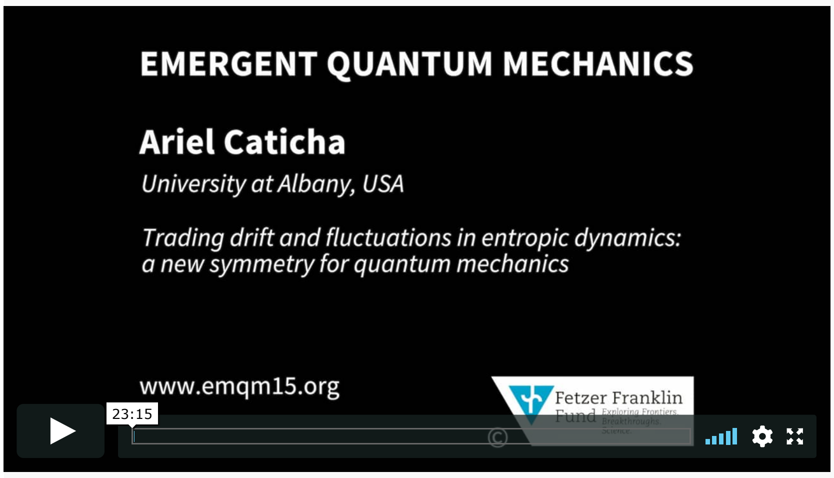

Entropic Dynamics (ED) is a framework that allows the formulation of dynamical theories as an application of entropic methods of inference. In the generic application of ED to derive the Schrödinger equation for N particles the dynamics is a non-dissipative diffusion in which the system follows a "Brownian" trajectory with fluctuations superposed on a smooth drift. The physical input is introduced through constraints that separately control the fluctuations and the drift.
There is a set of N constraints that controls the fluctuations. The central role played by the corresponding Lagrange multipliers with (one for each particle) is well understood: they serve to regulate the flow of time, and the differences among the are associated to differences in the mass of the particles.
There is another constraint involving a "drift" potential that correlates the motions of different particles. The drift potential contributes to the phase of the wave function and it is ultimately responsible for such quantum effects as interference and entanglement. The corresponding multiplier controls the strength of the drift motion relative to the fluctuations. The single-valuedness of the quantum wave function requires that must take integer values.
In this work we explore a new symmetry of quantum mechanics: we show that different "microscopic" models at the sub-quantum level lead to the same "macroscopic" behavior at the quantum level. More specifically, models with different values of can lead to the same Schrödinger equation.
The limit is of particular interest: the drift prevails over the fluctuations and the system evolves along the smooth lines of probability flow. Thus ED includes the causal or Bohmian form of quantum mechanics as a special limiting case. We further show that the Heisenberg uncertainty relations are an osmotic or diffusive effect even in the no-fluctuation Bohmian limit. Finally, we note that ED allows the construction of a theory - a non-dissipative dynamics with fluctuations but no quantum potential - that is neither classical nor quantum. In the limit this hybrid theory is fully equivalent to classical mechanics.

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Profile

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Department of Physics, University at Albany, USA

Professor and Associate Chair of Physics Ariel Caticha strongly believes that "physics is learned by doing." To encourage students to join him on his voyage of discovery, the scholar – internationally recognized for his work on a "theory of X-ray and neutron scattering by thin film multilayers" and "capillary waveguides for soft X-rays and neutrons" – makes himself accessible to his undergraduate and graduate students both inside and outside the classroom.

Caticha is also noted for his enthusiasm and for his ability to convey subtle concepts. These talents, combined with his accessibility, consistently earn him high marks from students who evaluate his teaching.

To date, Caticha has mentored six students toward their doctoral dissertations. In addition, he has served as a reviewer of National Science Foundation research grant proposals. The author of numerous peer-reviewed and invited articles, Caticha also referees such scientific journals as Physical Review Letters, Journal of Physics, and Journal of the Optical Society of America.

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Profile

BASIL J. HILEY

Theoretical Physics Research Unit, University of London

Basil J. Hiley is a British quantum physicist and professor emeritus of the University of London. He received the Majorana Prize "Best person in physics" in 2012.

Long-time co-worker of David Bohm, Hiley is known for his work with Bohm on implicate orders and for his work on algebraic descriptions of quantum physics in terms of underlying symplectic and orthogonal Clifford algebras. Hiley co-authored the book The Undivided Universe with David Bohm, which is considered the main reference for Bohm's interpretation of quantum theory.

The work of Bohm and Hiley has been characterized as primarily addressing the question "whether we can have an adequate conception of the reality of a quantum system, be this causal or be it stochastic or be it of any other nature" and meeting the scientific challenge of providing a mathematical description of quantum systems that matches the idea of an implicate order.

Basil Hiley was born 1935 in Burma, where his father worked for the military for the British Raj. He moved to Hampshire, England, at the age of twelve, where he attended secondary school. His interest in science was stimulated by his teachers at secondary school and by books, in particular The Mysterious Universe by James Hopwood Jeans and Mr Tompkins in Wonderland by George Gamow.

Hiley performed undergraduate studies at King's College London. He published a paper in 1961 on the random walk of a macromolecule, followed by further papers on the Ising model, and on lattice constant systems defined in graph theoretical terms. In 1962 he obtained his PhD from King's College in condensed matter physics, more specifically on cooperative phenomena in ferromagnets and long chain polymer models, under the supervision of Cyril Domb and Michael Fisher.

Hiley first met David Bohm during a week-end meeting organized by the student society of King's College at Cumberland Lodge, where Bohm held a lecture. In 1961 Hiley was appointed assistant lecturer at Birkbeck College, where Bohm had taken the chair of Theoretical Physics shortly before. Hiley wanted to investigate how physics could be based on a notion of process, and he found that David Bohm held similar ideas. He reports that during the seminars he held together with Roger Penrose he was particularly fascinated by John Wheeler's "sum over three geometries" ideas that he was using to quantise gravity.

Hiley worked with David Bohm for many years on fundamental problems of theoretical physics. Initially Bohm's model of 1952 did not feature in their discussions; this changed when Hiley asked himself whether the "Einstein-Schrödinger equation", as Wheeler called it, might be found by studying the full implications of that model. They worked together closely for three decades. Together they wrote many publications, including the book The Undivided Universe: An Ontological Interpretation of Quantum Theory, published 1993, which is now considered the major reference for Bohm's interpretation of quantum theory.

In 1995, Basil Hiley was appointed to the chair in physics at Birkbeck College at the University of London. He was awarded the 2012 Majorana Prize in the category The Best Person in Physics for the algebraic approach to quantum mechanics and furthermore in recognition of "his paramount importance as natural philosopher, his critical and open minded attitude towards the role of science in contemporary culture".

(source: Wikipedia)

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SPEAKER
Basil J. Hiley

FIELD OF SCIENCE
Physics

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WEAK VALUES, LOCAL MOMENTUM AND TANGENT GROUPOIDS

Basil J. Hiley

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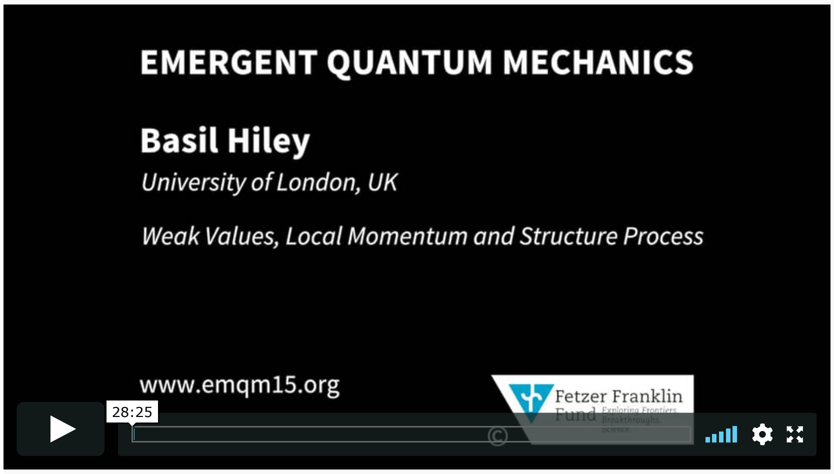

The weak value of the momentum operator gives rise to a complex number. The real part can be given a meaning in terms of the Bohm momentum, which is used to calculate streamlines often interpreted as “particle trajectories”. The appearance of an imaginary component throws doubts on this particular interpretation. I will show how the values appear from the difference between left and right translations in a non-commutative symplectic space. Together with some relatively recent mathematical results in non-commutative geometry, this suggests a dynamical geometric interpretation of quantum phenomena in which a ‘particle’ possesses internal degrees of freedom, giving a structure that is very different from that of a classical particle point particle. Nevertheless when the internal structure is neglected, the theory reduces to the usual classical Hamilton –Jacobi theory which is based on a commutative symplectic phase space. I will give an overview of this approach.

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SPEAKER
Bei-Lok Hu

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GRAVITATIONAL CAT STATE

Bei-Lok Hu

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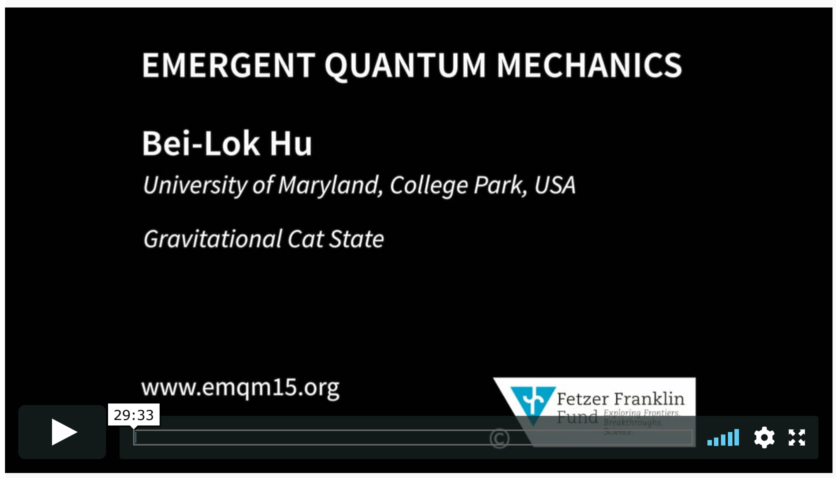

We investigate the nature of a gravitational two-state system (G2S) in the simplest setup in Newtonian gravity. In a quantum description of matter a single motionless massive particle can in principle be in a superposition state of two spatially-separated locations. This superposition state in gravity, or gravitational cat state, would lead to fluctuations in the Newtonian force exerted on a nearby test particle. The central quantity of importance for this inquiry is the energy density correlation. This corresponds to the noise kernel in stochastic gravity theory, evaluated in the weak field nonrelativistic limit. In this limit, quantum fluctuations of the stress energy tensor manifest as the fluctuations of the Newtonian force. We describe the properties of such a G2S system and present two ways of measuring the cat state for the Newtonian force, one by way of a classical probe, the other a quantum harmonic oscillator. Our findings include: (i) mass density fluctuations persist even in single particle systems, and they are of the same order of magnitude as the mean; (ii) a classical probe generically records a non-Markovian fluctuating force; (iii) a quantum probe interacting with the G2S system may undergo Rabi oscillations in a strong coupling regime. This simple prototypical gravitational quantum system could provide a robust testing ground to compare predictions from alternative quantum theories, since the results reported here are based on standard quantum mechanics and classical gravity.
*Based on Charis Anastopoulos, Bei-Lok Hu, “Probing a Gravitational Cat State”, Class. Quant. Grav. (2015) [arXiv:1504.03103]

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Participation

EmQM17 - Towards Ontology of Quantum Mechanics and the Conscious Agent

EmQM15 - Emergent Quantum Mechanics

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Profile

BEI-LOK HU

Maryland Center for Fundamental Physics and Joint Quantum Institute University of Maryland

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Prof Bei-Lok Hu got his PhD in theoretical physics from Princeton University in 1972 under the late Professor John A. Wheeler. After postdoctoral work at Stanford University, University of California, Berkeley and Santa Barbara in mathematics, physics and astrophysics, he was appointed an honorary research fellow at Harvard University in 1979 before he assumed his current position at the University of Maryland in 1980.

Prof Hu's research in the 70's was on quantum field theory in curved spacetime with applications to quantum processes in the early universe, for that work he was elected Fellow of the American Physical Society. Professor Hu began pioneering work on nonequilibrium quantum field theory in the 80's which resulted in a book with Dr. Calzetta by this title published in 2008 in the Cambridge Monograph in Mathematical Physics series. In 1990 Prof Hu began his seminal work on quantum decoherence and non-Markovian processes of open quantum systems. Since 2000 he has been studying quantum entanglement dynamics in atomic-optical systems with applications to quantum information processing. He is a founding fellow of the Joint Quantum Institute dedicated to the advancement of quantum science and its applications. He is also the chief architect in the inauguration of the International Society for Relativistic Quantum Information in 2010. His current research interest is on foundational issues of quantum and statistical mechanics behind macroscopic quantum phenomena and quantum thermodynamics.

Prof Hu is a world-renowned leader in quantum gravity research. His long-held critically independent viewpoint that general relativity is a hydrodynamic theory first presented at the Second Sakharov Conference in 1996 has, alongside with his Maryland colleague Jacobson's 1995 paper on viewing Einstein's equation as an equation of state, as well as work from the condensed matter community by Volovik and Wen, helped ushered in a vibrant field known today as emergent gravity.

(source: HKUST Jockey Club Institute for Advanced Study)

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Participation

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Profile

BRUCE CARLSON

Department of Cell & Developmental Biology, University of Michigan Medical School, USA

Bruce M. Carlson, M.D., Ph.D. is Professor Emeritus of Anatomy and Cell Biology at the University of Michigan. After receiving an M.S. in ichthyology at Cornell University, he completed his medical and doctoral studies at the University of Minnesota. Over 40 years, he was a faculty member in the Departments of Anatomy and Cell Biology and Biology at the University of Michigan. After stepping down as Chair of Anatomy and Cell Biology, he directed the Institute of Gerontology. His research involved limb and muscle regeneration, limb embryology and the biology of aging and denervated muscle.

Along with 200 papers, he has authored 13 books on regeneration, embryology and lake biology and has edited another 15 symposium volumes and translations. He has received a number of awards, including the AAAS Newcomb-Cleveland Prize, the Henry Gray Award of the American Association of Anatomists, which he served as President, and membership in the Russian Academy of Natural Sciences. He has conducted research for extended periods in the USSR, Czechoslovakia, the Netherlands, Finland and New Zealand. His retirement activities include writing books and directing a long-term study of pike growth in an isolated northern Minnesota lake.

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Participation

EmQM15 - Emergent Quantum Mechanics

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Profile

ČASLAV BRUKNER

Vienna Center for Quantum Science and Technology, University of Vienna, AT

Since 2014 University Professor, University of Vienna
Since 2013 Director of the Institute for Quantum Optics and Quantum Information (IQOQI) Vienna (www.iqoqi-vienna.at)
Since 2008 Visiting Professor, University of Belgrade, Serbia
Since 2006 Faculty member, Doctoral Program "Complex Quantum Systems" (www.coqus.at) at the University of Vienna, and Vienna University of Technology
2003-2013 Außerordentlicher Professor, Faculty of Physics, University of Vienna
2005-2008 Senior Scientist, Institute for Quantum Optics and Quantum Information (IQOQI), Austrian Academy of Sciences, Vienna, Austria.
2005-2007 Chair Professor, Tsinghua University, Beijing, China
2004 Marie Curie Fellow, Imperial College London, UK
1999-2003 Vertragsassistent, Faculty of Physics, University of Vienna, Austria.
1998-1999 Research Assistant, Institute of Experimental Physics, University of Vienna
1994-1999 Scientific Researcher, Institute of Experimental Physics, University of Innsbruck Education
2003 Habilitation in Quantum Physics, University of Vienna
1999 Dr. Tech in Physics, Vienna University of Technology
1995 MSc in Physics, University of Vienna

VIDEOS WITH ČASLAV BRUKNER

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Quantum Clocks and Time

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QUANTUM CLOCKS AND TIME

Časlav Brukner

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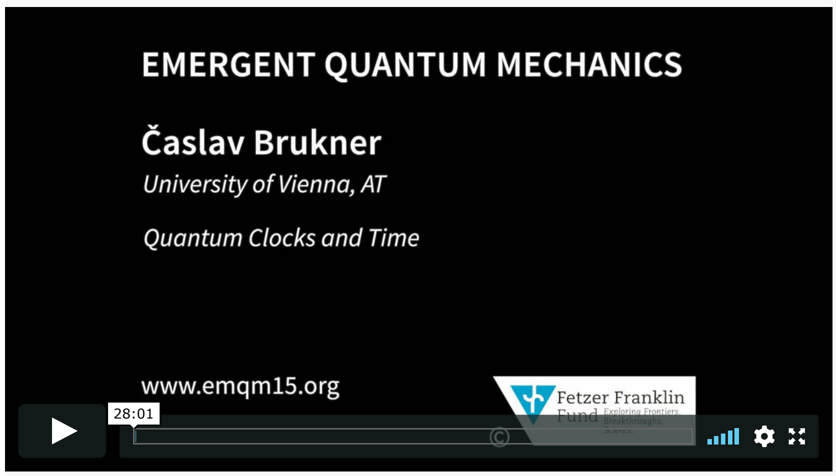

In general relativity, the picture of spacetime assigns an ideal clock to each spacetime point. Being ideal, gravitational effects due to these clocks are ignored and the flow of time according to one clock is not affected by the presence of surrounding clocks. However, if time is defined operationally, as a pointer position of a physical clock that obeys the laws of quantum mechanics and general relativity, such a picture is at most a convenient fiction. We show that the mass-energy equivalence implies gravitational interaction between the clocks, while the superposition of energy eigenstates leads to a non-fixed metric background. Based only on the assumption that both quantum mechanics and general relativity are valid in this situation, we show that the clocks necessarily get entangled through time dilation effect, which eventually leads to a loss of coherence of a single clock. Hence, the time as measured by a single clock is not well-defined. However, the general relativistic notion of time is recovered in the classical limit of clocks.

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Info

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Consciousness, Foundations

Participation

EmQM17 - Towards Ontology of Quantum Mechanics and the Conscious Agent

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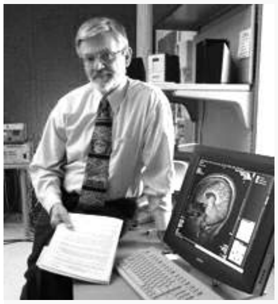
Profile

CHRISTOPHER GREEN

Wayne State University School of Medicine; Detroit Medical Center; Chinese Academy of Sciences



Christopher Green, M.D., Ph.D., FAAFS is Professor and Assistant Dean for China/Asia Pacific at Wayne State University School of Medicine, and at Detroit Medical Center Departments of Diagnostic Radiology and Psychiatry, and at the Chinese Academy of Sciences. Previously he was Assistant National Intelligence Officer Executive Branch, US Government, and later Chief Technology Officer Asia-Pacific General Motors. He also lived in Washington D.C., China and Singapore.

Kit founded and serves on the boards of several international neurotechnology and genomic companies. He uses high-field MRI for patients with complex forensic neurological disorders. He pursued his Ph.D. and M.D. degrees at Wisconsin, Colorado, and Ciudad Juarez University Schools of Medicine and is medically licensed in many states and WHO countries. As Holder of the National Intelligence Medal, and Lifetime Member of the National Research Council and the National Academy of Sciences, Kit has served and chaired numerous Department of Defense Science Boards and has authored over 20 academic monographs and studies in neurology, and biophysics. His passion is in brain imaging, neurotoxicology and genomics, and cognition. He is a Fellow in the American Academy of Forensic Sciences.

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Event

EMQM15 – EMERGENT QUANTUM MECHANICS

23/10 – 25/10/2015, Vienna University of Technology

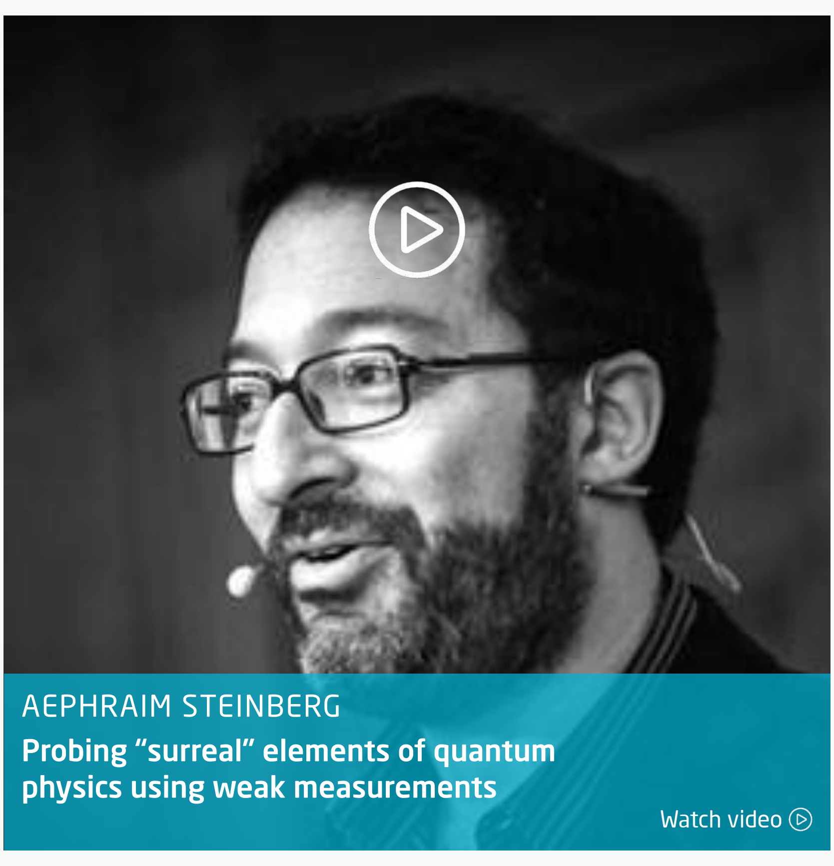
Videos Speakers Publications Event-Info

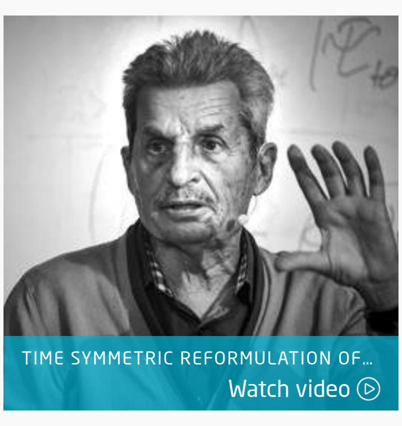
The symposium "EmQM15 - Emergent Quantum Mechanics" invites the open exploration of the quantum state as a reality. The resurgence of interest in ontological quantum theory, including both deterministic and indeterministic approaches, challenges long held assumptions and directs focus towards the following questions:

- Is the world local or nonlocal? What is the nature of quantum nonlocality?
- If nonlocal, i.e., superluminal, influences exist then why can't they be used for superluminal signalling and communication?
- How is the role of the scientific observer/agent to be accounted for in realistic approaches to quantum theory?
- How could recent developments in the field of space-time as an emergent phenomenon advance new insight at this research frontier?
- What new experiments might contribute to new understanding?

These and related questions will be addressed in the context also of a possible "deeper level theory" for quantum mechanics that interconnects three fields of knowledge: emergence, the quantum, and information. Could there appear a revised image of physical reality from recognizing new links between emergence, the quantum, and information? The symposium provides a forum for considering (i) current theoretical and conceptual obstacles which need to be overcome as well as (ii) promising developments and research opportunities on the way towards realistic quantum mechanics. Contributions are invited that present current advances in both standard as well as unconventional approaches.

VIDEOS





- **YAKIR AHARONOV:** *Time Symmetric Reformulation of Quantum Mechanics*
- **MARKUS ARNDT:** *Quantum optics with nanobiological matter*
- **PETER BARKER:** *Weak measurements of atomic momentum in a matter-wave interferometer*
- **ANGELO BASSI:** *Models of spontaneous wave function collapse: what they are, and how they can be tested*
- **HERMAN BATELAAN:** *Double slit electron diffraction*
- **KONSTANTIN BLIOKH:** *Field-Theory Revolution for Optics: Revisiting Momentum and Angular Momentum of Light*
- **ČASLAV BRUKNER:** *Quantum Clocks and Time*
- **ARIEL CATICHA:** *Trading drift and fluctuations in entropic dynamics: a new symmetry for quantum mechanics*
- **ERIC CAVALCANTI:** *The Two Bell's Theorems of John Bell and Causal Emergence*
- **ANA MARÍA CETTO:** *Two-electron system correlated by the zero-point field: physical explanation for the spin-statistics connection*
- **LAJOS DIÓSI:** *Nonlinear Schrödinger Equation in Foundations: Summary of 4 Catches*
- **HANS-THOMAS ELZE:** *Quantum Features of Natural Cellular Automata*
- **ROBERT FLACK:** *Measuring the weak value of atomic spin*
- **NICOLAS GISIN:** *Quantum correlations in Newtonian space and time: arbitrarily fast communication or nonlocality*
- **MAURICE DE GOSSON:** *Weak values and the reconstruction problem in Born-Jordan quantization*
- **GERHARD GRÖSSING:** *Conditions for Lorentz-invariant superluminal information transfer without signaling*
- **YUJI HASEGAWA:** *Foundations of Quantum Mechanics studied in Matter-Wave Optics. Quantum Cheshire-Cat and Uncertainty Relations*
- **BASIL J. HILEY:** *Weak Values, Local Momentum and Tangent Groupoids*
- **GERARD 'T HOOFT:** *How quantization of gravity leads to a discrete space-time*
- **BEI-LOK HU:** *Gravitational Cat State*
- **MARIAN KUPCZYNSKI:** *EPR Paradox, Quantum Nonlocality and Physical Reality*
- **MATT LEIFER:** *The reality of the quantum state from Kochen-Specker contextuality*
- **THEO NIEUWENHUIZEN:** *Walking on quantum foundations*
- **HRVOJE NIKOLIC:** *How to reconcile non-local reality and local non-reality*
- **TRAVIS NORSEN:** *Bohmian conditional wave functions and the reality of the quantum state*
- **XAVIER ORIOLS:** *Can Decoherence make quantum theories unfalsifiable? Understanding the quantum-to-classical transition without it*
- **THANU PADMANABHAN:** *Atoms of Spacetime and the Nature of Gravity*
- **WILLIAM POIRIER:** *Quantum Mechanics Without Wavefunctions: When quantum worlds collide*
- **HANS DE RAEDT:** *The unreasonable effectiveness of quantum theory: a logical inference approach*
- **HELMUT RAUCH:** *Ignorance governs quantum experiments*
- **MARTIN RINGBAUER:** *Measurements on the Reality of the Wavefunction*
- **AEPHRAIM STEINBERG:** *Probing "surreal" elements of quantum physics using weak measurements*
- **JEFF TOLLAKSEN:** *The Quantum pigeonhole principle and localizing Kochen-Specker contextuality with weak measurements*
- **LEV VAIDMAN:** *Ontology of the wave function*
- **JAN WALLECZEK:** *Free Will Theorems in Nonlocal Information Transfer without Nonlocal Communication*
- **JAN WALLECZEK:** *Is the World Local or Nonlocal? - Towards an Emergent Quantum Mechanics 80 Years after EPR*
- **GREGOR WEIHS:** *Multipath Interference Tests of Quantum Mechanics*
- **SILKE WEINFURTNER:** *Hydrodynamic simulations of rotating and non-rotating black holes*
- **HOWARD WISEMAN:** *Ensembles of Bohmian trajectories: Real, Surreal, and Hyper-real*

PUBLICATIONS

Book-Publication

IOP science

EmQM15: Emergent Quantum Mechanics 2015
A special issue of "IOP Publishing"

These proceedings comprise the invited lectures of the third international symposium on Emergent Quantum Mechanics (EmQM15), which was held at the Vienna University of Technology in Vienna, Austria, 23-25 October 2015.

For the articles please click here.

SPEAKERS

Yakir Aharonov	Nicolas Gisin	Xavier Oriols
Markus Arndt	Maurice de Gosson	Thanu Padmanabhan
Peter Barker	Christopher Green	Hans de Raedt
Angelo Bassi	Gerhard Grössing	Helmut Rauch
Herman Batelaan	Yuji Hasegawa	Martin Ringbauer
Konstantin Bliokh	Basil J. Hiley	Aephraim Steinberg
Časlav Brukner	Gerard 't Hooft	Jeff Tollaksen
Bruce Carlson	Bei-Lok Hu	Lev Vaidman
Ariel Caticha	Marian Kupczynski	Jan Walleczek
Eric Cavalcanti	Matt Leifer	Gregor Weihs
Ana María Cetto	Theo Nieuwenhuizen	Silke Weinfurtner
Lajos Diósi	Hrvoje Nikolic	Howard Wiseman
Hans-Thomas Elze	Travis Norsen	

EVENT INFO

Website: www.emqm15.org
Location: Vienna University of Technology
Date: 23/10 – 25/10/2015
Organizers:
Jan Walleczek
Fetzer Franklin Fund, USA, and Phenoscience Laboratories, Berlin, Germany
Gerhard Grössing
Austrian Institute for Nonlinear Studies, Vienna, Austria

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EmQM17 - Towards Ontology of Quantum Mechanics and the Conscious Agent

EmQM13 – 3th International Symposium about Quantum Mechanics

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Participation

EmQM15 - Emergent Quantum Mechanics

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Profile

ERIC CAVALCANTI

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Publications 1 to 3 are from my work on Biophysics as an undergraduate research assistant at PUC-Rio. Publications 4 to 9 came from my Masters' work on Atomic Collisions in the Van de Graff laboratory also at PUC-Rio.

After my Masters I spent about a year working in the "real world". Well, close to it – I worked for the Institute for Radioprotection at the National Nuclear Energy Commission, in Rio de Janeiro. After a while I decided to go back to the excitement of academic life but with a complete change of fields: from experimental Biophysics to Atomic Collisions to theoretical foundations of Quantum Mechanics. Publications from 10 forward refer to this current incarnation.

VIDEOS WITH ERIC CAVALCANTI

VIDEO

PHYSICS
The Two Bell's Theorems of John Bell and Causal Emergence

PAPERS FROM ERIC CAVALCANTI

Paper
EmQM15 – The Two Bell's Theorems of John Bell and Causal Emergence

Presentation
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Eric Cavalcanti

PLACE
Vienna University of Technology

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THE TWO BELL'S THEOREMS OF JOHN BELL AND CAUSAL EMERGENCE

Eric Cavalcanti Vienna University of Technology

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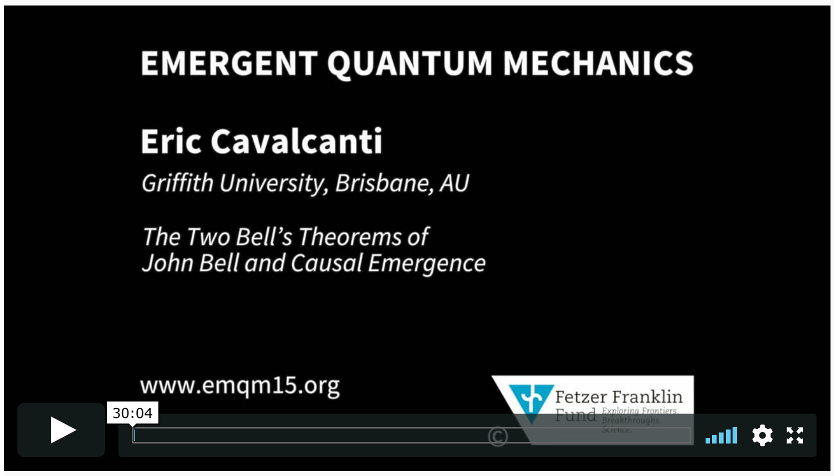

"Bell's theorem" can refer to two different theorems that John Bell proved, the first in 1964 and the second in 1976. His 1964 theorem is the incompatibility of quantum phenomena with the joint assumptions of Locality and Predetermination. His 1976 theorem is their incompatibility with the single property of Local Causality. This is contrary to Bell's own later assertions, that his 1964 theorem began with the assumption of Local Causality, even if not by that name. Although the two Bell's theorems are logically equivalent, their assumptions are not. Hence, the earlier and later theorems suggest quite different conclusions, embraced by operationalists and realists, respectively. Here we show how those amount to different assumptions about causation, and propose an unifying version of Bell's theorem in which each camp could reject one assumption, happy that the remaining assumptions reflect its weltanschauung. Formulating Bell's theorem in terms of causation is fruitful not just for attempting to reconcile the two camps, but also for better describing the ontology of different quantum interpretations and for more deeply understanding the implications of Bell's marvellous work. I'll conclude with some open questions and a puzzle regarding the emergence of agent-centric causal concepts in quantum theory.

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SPEAKER
Gerard 't Hooft

FIELD OF SCIENCE
Physics

DATE
25/10/2015

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HOW QUANTIZATION OF GRAVITY LEADS TO A DISCRETE SPACE-TIME

Gerard 't Hooft

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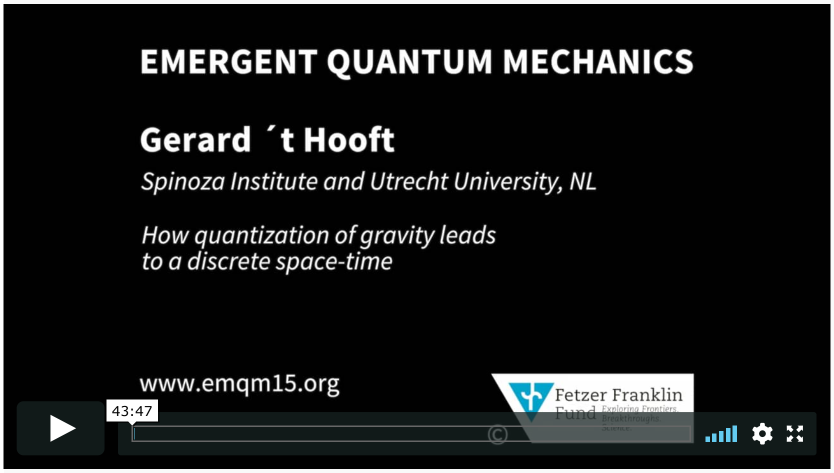

The idea that the Planck length is the smallest unit of length, and the Planck time the smallest unit of time, is natural and has been suggested many times. One can, however, also derive this more rigorously, using nothing more than the fact that black holes emit particles, according to Hawking's theory, and that these particles interact gravitationally.

It is then observed that the particles, going in and out, form quantum states bouncing against the horizon. The dynamics of these microstates can be described in a partial wave expansion, but Hawking's expression for the entropy then requires a cut-off in the transverse momentum, in the form of a Brillouin zone, and this implies that these particles live on a lattice.

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Participation

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Profile

GERARD 'T HOOFT

Institute for Theoretical Physics, Department of Physics and Astronomy, Faculty of Science of Utrecht University, NL

His work concentrates on gauge theory, black holes, quantum gravity and fundamental aspects of quantum mechanics. His contributions to physics include a proof that gauge theories are renormalizable, dimensional regularization, and the holographic principle. After obtaining his doctorate 't Hooft went to CERN in Geneva, where he had a fellowship. He further refined his methods for Yang-Mills theories with Veltman (who went back to Geneva). In this time he became interested in the possibility that the strong interaction could be described as a massless Yang-Mills theory, i.e. one of a type that he had just proved to be renormalizable and hence be susceptible to detailed calculation and comparison with experiment.

According to his calculations, this type of theory possessed just the right kind of scaling properties (asymptotic freedom) that this theory should have according to deep inelastic scattering experiments. This was contrary to popular perception of Yang-Mills theories at the time, that like gravitation and electrodynamics, their intensity should decrease with increasing distance between the interacting particles; such conventional behaviour with distance was unable to explain the results of deep inelastic scattering, whereas 't Hooft's calculations could. When he mentioned his results at a small conference at Marseilles in 1972, Kurt Symanzik urged him to publish this result. He did not, and the result was eventually rediscovered and published by Hugh David Politzer, David Gross, and Frank Wilczek in 1973, which led to them earning the 2004 Nobel Prize in Physics.

VIDEOS WITH GERARD 'T HOOFT

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How quantization of gravity leads to a discrete space-time

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SPEAKER
Gerhard Grössing

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Vienna University of Technology

FIELD OF SCIENCE
Physics

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CONDITIONS FOR LORENTZ-INVARIANT SUPERLUMINAL INFORMATION TRANSFER WITHOUT SIGNALING

Gerhard Grössing Vienna University of Technology

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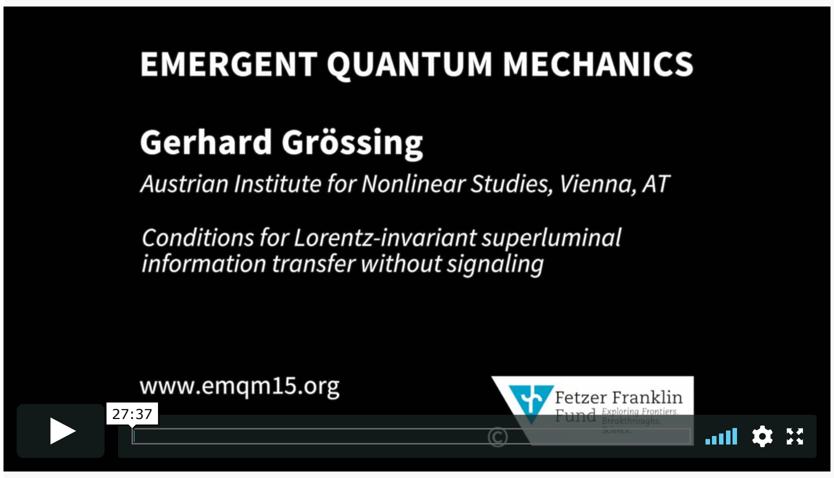

We understand emergent quantum mechanics in the sense that quantum mechanics describes processes of physical emergence relating an assumed sub-quantum physics to macroscopic boundary conditions. The latter can be shown to entail top-down causation, in addition to usual bottom-up scenarios. With this example it is demonstrated that definitions of “realism” in the literature are simply too restrictive.

A prevailing manner to define realism in quantum mechanics is in terms of pre-determination independent of the measurement. With our counter-example, which actually is ubiquitous in emergent, or self-organizing, systems, we argue for realism without pre-determination. We refer to earlier results of our group showing how the guiding equation of the deBroglie-Bohm interpretation can be derived from a theory with classical ingredients only.[1-3] Essentially, this corresponds to a “quantum mechanics without wave functions“ in ordinary 3-space, albeit with nonlocal correlations.

This, then, leads to the central question of how to deal with the nonlocality problem in a relativistic setting. We here show that a basic argument discussing the allegedly paradox time ordering of events in EPR-type two-particle experiments falls short of taking into account the contextuality of the experimental setup. Consequently, we then discuss under which circumstances (i.e. physical premises) superluminal information transfer (but not signaling [4]) may be compatible with a Lorentz-invariant theory.

Finally, we argue that the impossibility of superluminal signaling – despite the presence of superluminal information transfer – is not the result of some sort of conspiracy (á la “Nature likes to hide”), but the consequence of the impossibility of infinite precision of a state’s preparation, or of the no-cloning theorem, respectively.

[1] G. Grössing, “The Vacuum Fluctuation Theorem: Exact Schrödinger Equation via Nonequilibrium Thermodynamics”, Phys. Lett. A 372 (2008) 4556-4563. quant-ph/arXiv:0711.495

[2] G. Grössing, S. Fussy, J. Mesa Pascasio, and H. Schwabl, “Extreme beam attenuation in double-slit experiments: Quantum and subquantum scenarios”, Ann. Phys. 353 (2015) 271–281. arXiv:1406.1346 [quant-ph]

[3] G. Grössing, S. Fussy, J. Mesa Pascasio, and H. Schwabl, “Implications of a deeper level explanation of the deBroglie-Bohm version of quantum mechanics”. Quantum Stud.: Math. Found. 2, 1 (2015), 133-140

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Profile

GERHARD GRÖSSING

Austrian Institute for Nonlinear Studies

Dr. Gerhard Grössing is Co-Founder and Director of the Austrian Institute for Nonlinear Studies (AINS) in Vienna, Austria. He studied physics and mathematics at the University of Vienna and at Iowa State University, USA. During his post-doctoral work at Vienna's Atominstitut, he coined the term and developed, together with Anton Zeilinger, the first "Quantum Cellular Automata", and he developed an early variant of an "emergent" quantum theory named "Quantum Cybernetics" whose main results were published as a monograph with Springer Verlag, New York.

His major research interests cover the foundations of quantum theory and new tools in complex systems research. Apart from his scientific work per se, he has a continued interest in the fields of philosophy and foundations of science, where he also published numerous articles and two books. In recent years, the research of Gerhard Grössing and the AINS has focused on the development of an "Emergent Quantum Mechanics". He has organized at the University of Vienna the first international conference exclusively devoted to this promising and rapidly developing field, whose contributions are collected in a volume published by the Institute of Physics

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MULTIPATH INTERFERENCE TESTS OF QUANTUM MECHANICS

Gregor Weihs

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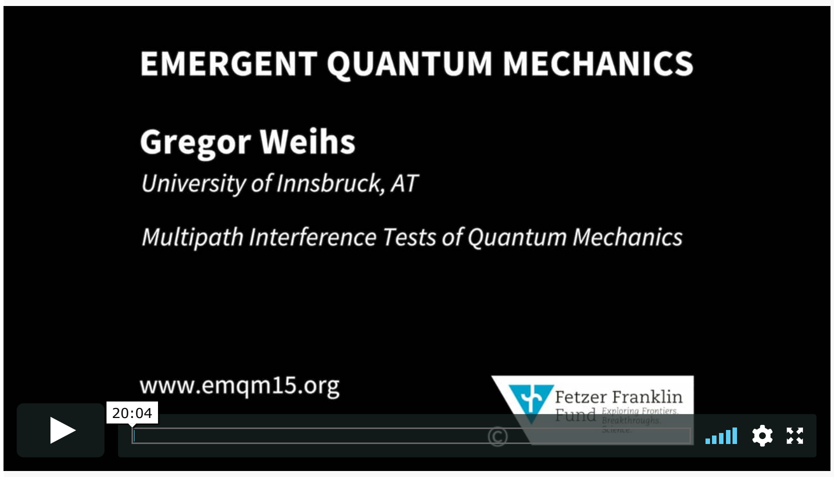

Quantum mechanics can be considered a special case of the class generalized probabilistic physical theories. One way of classifying general probabilistic theories is to look at how they deviate from classical probabilistic theories based on classical ensembles, distributions and random variables. Quantum mechanics, for example, deviates because it derives probabilities from wavefunctions and thus exhibits interference.By virtue of Born's rule, all interference terms stem from pairs of paths. Other probabilistic theories could go beyond that [1] and allow higher-order interference terms, thus violating Born's rule.
Using multipath interferometers [2,3] our bound on the deviation from ordinary quantum interference is approaching 10-5 , with a good part of the uncertainty originating from our limited accuracy in determining detector nonlinearity [4].
We also use our multipath interferometers to test for the generalization of quantum mechanics in terms of the underlying numbers, i.e. whether hypercomplex quantum mechanics is allowed or not [5]. Waveguide interferometers with integrated shutters are approaching the required high interference visibilities.

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GREGOR WEIHS

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Gregor Weihs is Professor of Photonics and Head of the Institute for Experimental Physics at the University of Innsbruck and an Associate of the University of Waterloo's Institute for Quantum Computing. While being on leave from his position in Vienna he spent two and a half years as Consulting Assistant Professor at Stanford University collaborating with the group of Yoshihisa Yamamoto (now at RIKEN) and Assistant Professor of Research at Tokyo University working on semiconductor quantum optics with Yasuhiko Arakawa's group. Gregor Weihs was DOC-fellow of the Austrian Academy of Sciences; he won the Appreciation Award of the Austrian Ministry of Science and Transport and the Loschmidt-Prize of the Chemical-Physical Society in Vienna. In 2007 he was awarded the Canada Research Chair in Quantum Photonics and in 2010 a Starting Grant by the European Research Council. In 2011 he was elected into the Austrian Academy of Sciences as a member of the Young Academy. His memberships include the Chemical-Physical, Austrian and American Physical Societies, the Canadian Association of Physicists, as well as the Optical Society of America. He is a fellow of the QIP program of the Canadian Institute for Advanced Research, and in addition currently holds grants from the European Research Council (ERC), and the Austrian Science Fund (FWF). In his research interests include fundamental physics both experimental and theoretical, quantum and semiconductor optics and quantum information. He currently focuses on novel sources of entangled photon pairs from nonlinear waveguides, via strong coupling in semiconductor microcavities, and from semiconductor quantum dots. He further does research is in quantum communication and the foundations of physics.

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HANS DE RAEDT

Faculty of Science and Engineering, University of Groningen, NL

In 1976, Prof. dr. H. De Raedt received the Ph.D. degree from the University of Antwerp, Belgium, for work on magnetism in one dimension. Since 1990 he is Professor of Computational Physics at the Department of Physics, University of Groningen (the Netherlands), where he leads the Computational Physics group of the Zernike Institute for Advanced Materials. His current research interests include computational electrodynamics, nanoscale magnetism, (quantum) statistical physics, and event-based simulation methods of quantum phenomena.

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THE UNREASONABLE EFFECTIVENESS OF QUANTUM THEORY: A LOGICAL INFERENCE APPROACH

Hans de Raedt

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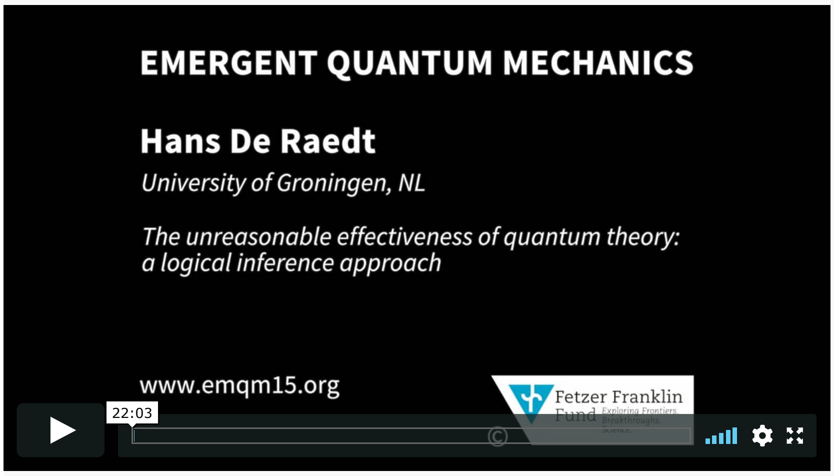

We develop the thesis that logical inference provides a framework to establish a bridge between data gathered through experiments and its description in terms of human-made concepts. It is shown that logical inference applied to experiments for which the observed events are independent and for which the frequency distribution of these events is robust with respect to small changes of the conditions under which experiments are carried out yields, without introducing any concept of quantum theory, the quantum theoretical description in terms of the Schrödinger or the Pauli equation, the Stern-Gerlach or Einstein-Podolsky-Rosen-Bohm experiments etc. [1,2]. The extraordinary descriptive power of quantum theory then follows from the fact that it is plausible reasoning, that is common sense, applied to reproducible and robust experimental data.

[1] H. De Raedt, M.I. Katsnelson, and K. Michielsen, "Quantum theory as the most robust description of reproducible experiments", Ann. Phys. 347, 45 - 73 (2014).
[2] H. De Raedt, M.I. Katsnelson, H.C. Donker, and K. Michielsen, "Quantum theory as a description of robust experiments: Derivation of the Pauli equation", Ann. Phys. 359, 166 - 186 (2014).

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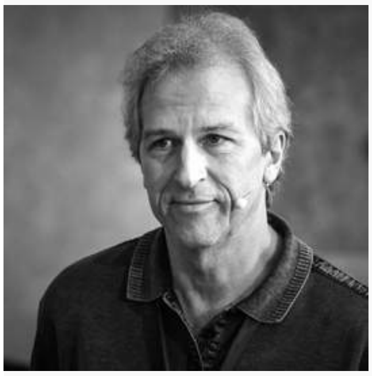

Hans-Thomas Elze is a theoretical physicist. - Phd at University of Frankfurt (1985), followed by positions in Berkeley, Helsinki, and 3 years spent at CERN. Professorships in Bremen, Regensburg, and Tucson (Arizona). Professor at Brazil's renowned Universidade Federal do Rio de Janeiro (1997-2004).

Affiliated with Universita di Pisa (since 2004). - Several Fellowships, notably Heisenberg Fellow Award (German science foundation, DFG) for quantum transport theory in gauge theories. Organizer of biannual DICE (foundations of physics) conferences in Italy since 2002.

Present interests include: entanglement entropy, decoherence, emergence of quantum mechanics.

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IGNORANCE GOVERNS QUANTUM EXPERIMENTS

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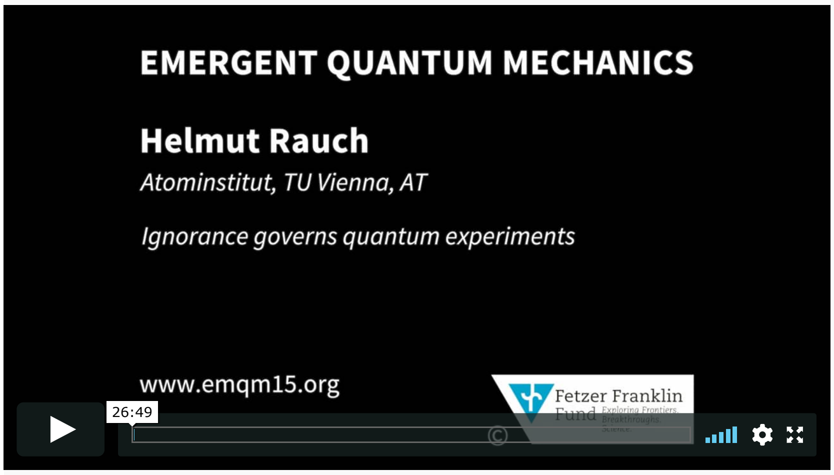

We discuss the situation related to neutron interference experiments. One describes these experiments with the time independent Schrödinger equation which combines particle features and features of the apparatus. This indicates that a lot of information from earlier experiments enters the description from the particle side as well as from the instrument side. This information comes from statistical measurements and causes an intrinsic random feature of the description. Thus the statistical output is a result of the statistical input. The Schrödinger equation then describes the situation in the limits of our knowledge of all boundary and initial conditions. Thus one does not know when a neutron enters the apparatus, thus one does not know when it will be detected at the end or one does not know which momentum the neutron has within the collimation range etc. Thus pre- and post-selection experiments can make the situation more clear but intrinsic limitations remain. Various such pre- and post-selection experiments in ordinary, in momentum, in spin and in the time domain will be described. Decoherence and the transition between the quantum and classical world seems to be a lack of knowledge of the interaction processes in the interaction with the environment. This guides us to a more event related description of the observed phenomena. In all these discussions the entanglement of various degrees of freedom with geometric phases should not be forgotten, since these are not taken into account in many cases.

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Profile

HELMUT RAUCH

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Helmut Rauch (born 22 January 1939 in Krems an der Donau, Lower Austria) is an Austrian physicist. He is specially known for his pioneering experiments on neutron interference. Rauch studied Physics at Vienna University of Technology and worked at Atominstitut Vienna. He has also been affiliated with Forschungszentrum Jülich and Institut Laue-Langevin in Grenoble. In 1974, Rauch, together with Ulrich Bonse and Wolfgang Treimer, demonstrated the first matter wave interference of Neutrons. This demonstrated the wave-like nature of neutrons for the first time and was another experimental proof that not only photons can be described by waves, but also massive particles. Further they demonstrated the fundamental symmetry of spin 1/2 particles under rotations.

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DOUBLE SLIT ELECTRON DIFFRACTION

Herman Batelaan Vienna University of Technology

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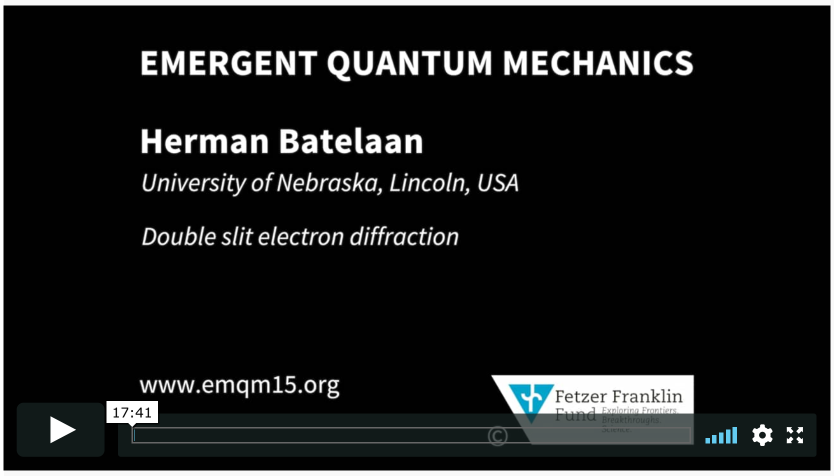

We measured diffraction of electrons from a grating of light [1] and recorded a movie of the build-up of the diffraction pattern one particle at a timefor the double slit [2]. In work done in Paris, macroscopic particle-wave duality with bouncing oil droplets was demonstrated for a double slit [3], which we have attempted to repeat. The philosophical implication of the oil droplet experiment is that it is acceptable to attempt to think of theories underlying quantum mechanics that have the capability to describe single Events in a deterministic fashion. The idea that the electromagnetic vacuum field under the boundary conditions presented by a double slit could be responsible for electron diffraction is decades old. Recently [4], this idea has been worked out in stochastic electrodynamics (SED) and provides a possible Explanation for double slit diffraction in a deterministic way. We investigated SED for the harmonic oscillator [5] under pulsed excitation as a test of the theory [6], and hope to extend this work to the double slit and to electrons passing by a wall, with the purpose of identifying experimental tests.

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[3] Couder, Y. & Fort, E. Phys.Rev. Lett. 97, 154101 (2006).
[4] Luis de la Pena, Ana, Maria Cetto, Andrea Valdes Hernandes, The Emerging Quantum, Springer 2015, p.323.
[5] Wayne Cheng-Wei Huang, H. Batelaan, Journal of Computational Methods in Physics, Volume 2013 (2013) Article ID 308538
[6] Wayne Cheng-Wei Huang, H. Batelaan,Found. of Phys.45, 333 (2015)

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HERMAN BATELAAN

Department of Physics and Astronomy, University of Nebraska

Herman Batelaan studies the fundamental interaction between light, electrons and atoms.

His interests focus on studying the foundations of quantum mechanics and electromagnetic interactions.

These studies include theoretical analysis, simulation using supercomputing (HCC and XSEDE), and a strong emphasis on experiment.

(source: Department of Physics & Astronomy)

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ENSEMBLES OF BOHMIAN TRAJECTORIES: REAL, SURREAL, AND HYPER-REAL

Howard Wiseman

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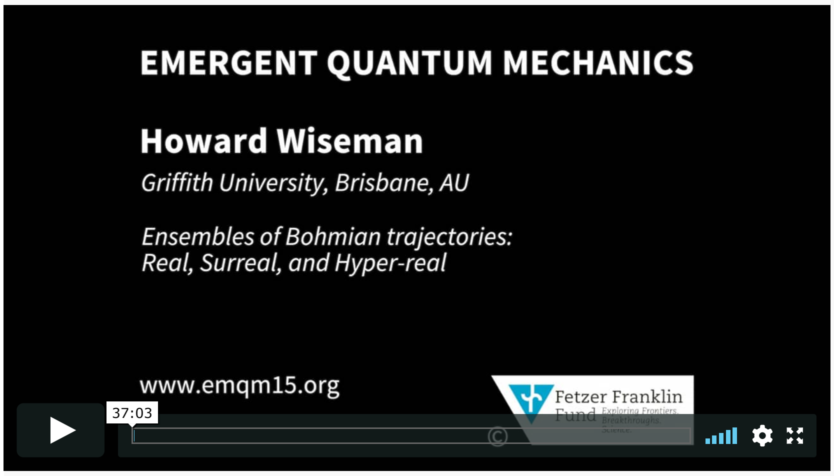

As suggested by me several years ago, and demonstrated more recently in the group of Steinberg, an ensemble of trajectories can be experimentally reconstructed with minimal assumptions about a system if one can make weak measurements of velocity and strong measurements of position. In particular for a particle with dynamics described by Schroedinger's equation, the thereby reconstructed trajectories are exactly those of Bohmian mechanics. In this sense, at least, one can claim the ensemble as something "real". However, under certain circumstances – when a detector can "fire" even when the Bohmian trajectory bypasses it – Bohmian trajectories have been criticised as being "surreal". I discuss how this is the flip-side to the nonlocality of Bohmian mechanics, which we know must be present in any realistic interpretation of quantum mechanics. I present joint experimental work with the Steinberg group with entangled photon pairs proving this point. Finally I discuss a relatively new, "hyper-real" approach to quantum mechanics in which the entire ensemble of Bohmian trajectories is taken to exist simultaneously. The profligate multiplication of reality in this "many interacting worlds" approach (joint work with Hall and Deckert) actually has some conceptual advantages over both the standard many worlds interpretation and the standard Bohmian interpretation. I will present numerical and analytical results suggesting that with a sufficiently enormous ensemble, the wavefunction may be superfluous.

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HOWARD WISEMAN

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Howard Mark Wiseman (born 19 June 1968) is a theoretical quantum physicist notable for his work on quantum feedback control, quantum measurements, quantum information, open quantum systems, the many interacting worlds interpretation of quantum mechanics, and other fundamental issues in quantum mechanics. Wiseman was born in Brisbane, Australia and received his B.Sc.(Hons) in Physics from the University of Queensland in 1991.

He completed his PhD in physics under Gerard J. Milburn at the University of Queensland in 1994, with a thesis entitled Quantum Trajectories and Feedback. After his PhD, Wiseman undertook a postdoc under Dan Walls at the University of Auckland. From 1996 to 2009 he held Australian Research Council (ARC) research fellowships. He is currently a Physics Professor at Griffith University, where he is the Director of the Centre for Quantum Dynamics. He is also an Executive Node Manager in the Centre for Quantum Computation and Communication Technology, an ARC Centre of Excellence. His awards include the Bragg Medal of the Australian Institute of Physics, the Pawsey Medal of the Australian Academy of Science and the Malcolm Macintosh Medal, one of the Prime Minister's Prizes for Science. He is a Fellow of the Australian Academy of Science, and a Fellow of the American Physical Society.

(source: Wikipedia)

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HOW TO RECONCILE NON-LOCAL REALITY AND LOCAL NON-REALITY

Hrvoje Nikolic Vienna University of Technology

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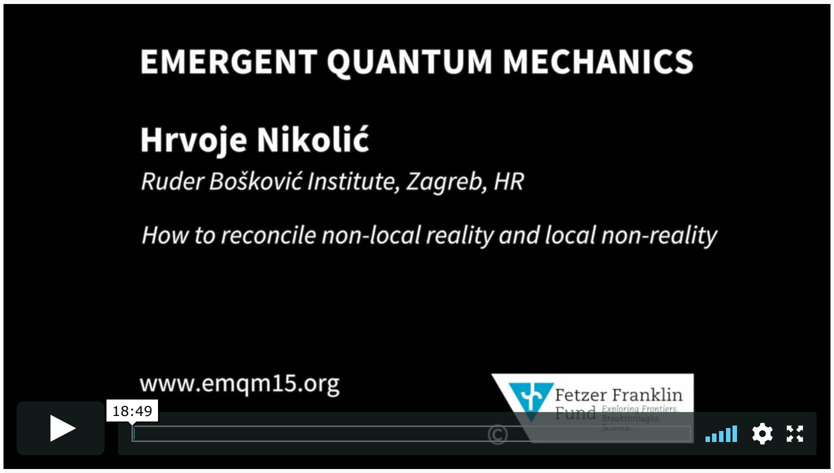

Non-local reality and local non-reality are two seemingly irreconcilable interpretations of quantum mechanics. We attempt to reconcile them by constructing a bridge, an interpretation of quantum mechanics that interpolates between them. It is done by solipsistic hidden variables (HV's), which is a theory of Bohmian-like particle trajectories associated only with the essential degrees of freedom of the observer, not with the observed objects. In contrast with the standard Bohmian HV's, nonlocality in solipsistic HV's can be substantially reduced down to microscopic distances inside the observer.

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HRVOJE NIKOLIC

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Hrvoje Nikolic, born in 1970 in Zagreb, Croatia, is a theoretical physicist working at the Theoretical Physics Division of Rudjer Boskovic Institute in Zagreb, Croatia. His research interests cover various foundational aspects of theoretical physics, including foundations of quantum mechanics, general relativity, cosmology, particle physics, quantum field theory and string theory.

Education

2001 PhD in physics (University of Zagreb)
1998 Master degree in physics (University of Zagreb)
1995 Bachelor degree in physics (University of Zagreb)

Awards and Achievements

- Ruđer-Bošković-Institute director award for a published paper in physics (2010)
- Honorable Mention of the Gravity Research Foundation 2006 Essay Competition
- Honorable Mention of the Gravity Research Foundation 2005 Essay Competition

Classes

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Featured Publications

- H. Nikolić, Horava-Lifshitz gravity, absolute time, and objective particles in curved space, Mod. Phys. Lett. A 25, 1595 (2010).
- H. Nikolić, QFT as pilot-wave theory of particle creation and destruction, Int. J. Mod. Phys. A 25, 1477 (2010).
- H. Nikolić, Resolving the black-hole information paradox by treating time on an equal footing with space, Phys. Lett. B 678, 218 (2009).
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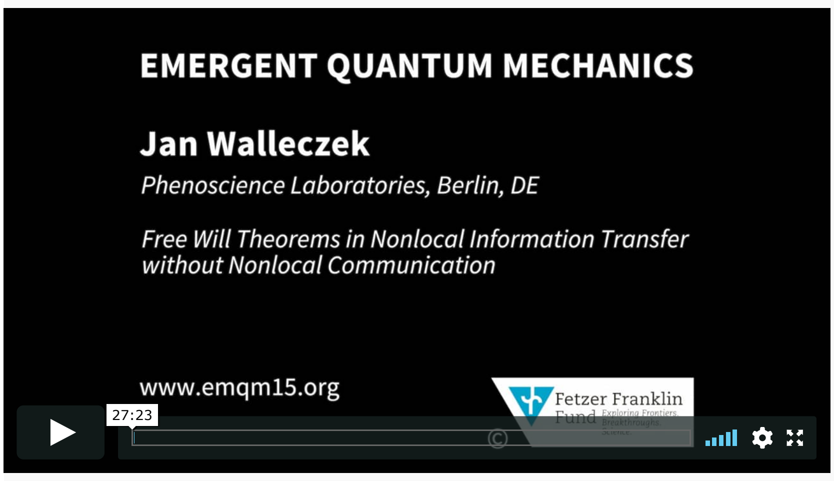
FREE WILL THEOREMS IN NONLOCAL INFORMATION TRANSFER WITHOUT NONLOCAL COMMUNICATION

Jan Walleczek Vienna University of Technology



How could an experimenter agent be in possession of 'free will' in a deterministic world? Central to the plausibility of ontological, realistic quantum mechanics is the question of the free choice of an experimenter. Specifically, how does the agent evade pre-determination by the past history of the universe? Equally central is the following question: Why is the known violation of setting or parameter independence in deterministic theories, such as de Broglie-Bohm theory, not in conflict with special relativity and the non-signalling theorem? This presentation reconsiders deep links between these questions and offers possible answers based on the concept of 'emergence'. The chief characteristic of emergence, self-organization, or complexity, theory is its account of the appearance of novel, unpredictable outcomes – whether physical, biological, or psychological in nature – based upon entirely deterministic relations (e.g., Walleczek, 2000).

The first part of this presentation reviews recent work which (i) countered the notion that axiomatic non-signalling refutes the possibility of deterministic quantum theories (Walleczek and Grössing, 2014) and (ii) introduced the distinction between 'Shannon signals' and 'non-Shannon signals' as part of a communication-theoretic analysis of the non-signalling theorem (Walleczek and Grössing, 2015). This latter distinction helps explain why the concept of nonlocal quantum information transfer need not be identified with superluminal signalling and communication.

The second part of the presentation compares the basic approaches – compatibilist and incompatibilist – towards the problem of free will in quantum mechanics and the non-signalling theorem. For the incompatibilist position, a frequent example is the "Free Will Theorem" by Conway and Kochen, and possible shortcomings of that proposal will be discussed. Another incompatibilist position is the well-known concept of "Super-deterministic Conspiracy", which, like the "Free Will Theorem", denies compatibility also between determinism and free will. For the compatibilist position, i.e., the view that free will can be compatible with determinism, the focus is on the – often misinterpreted – position of John S. Bell. Analysis of Bell's position reveals that he sought a free will theorem capable of upholding the crucial distinction between determinism and pre-determinism, i.e., "effective" free will (Bell, 1977). That distinction refers to the concept of "determinism without pre-determinism", in which the setting of a new boundary condition by an experimenter agent transforms an 'indefinite ontic structure' (IOS) into a 'definite ontic structure' (DOS).

In summary, two routes towards evading pre-determination of events can be identified. One route is fundamental (axiomatic) indeterminism (e.g., in orthodox quantum mechanics); the other route is operational (effective) IOS-DOS transitioning (e.g., in de Broglie-Bohm theory). Importantly, neither route is found to address the problem of the "free-willed control" – by an agent – of any physical events in nature. Therefore, either route – effective or axiomatic – may satisfy the requirement of unpredictability, i.e., lack of pre-determination, of an agent's choices based upon past information about the universe. In conclusion, "effective", not only "axiomatic", free will may be entirely sufficient to evade the danger of cosmic pre-determination.

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1 This work is funded in part by the Fetzer Franklin Fund of the John E. Fetzer Memorial Trust.

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IS THE WORLD LOCAL OR NONLOCAL? – TOWARDS AN EMERGENT QUANTUM MECHANICS 80 YEARS AFTER EPR

Jan Walleczek Vienna University of Technology

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80 years after Einstein, Podolsky, and Rosen (1935), workers in quantum foundations are still debating whether science must give up entirely the idea of an 'objective reality'. What is 'locality'? What is 'nonlocality'? What is 'the world'? What does it mean for an object 'to exist' in the first place? The question concerning 'ontology' has turned out to be a hard one to answer when it comes to reality's smallest dimensions – the quantum. Significantly, despite defending opposite ends of the metaphysical spectrum – indeterminism versus determinism – Bohr and Einstein were in complete agreement, however, on the impossibility of "action-at-a-distance", i.e., of the 'objective' or 'intrinsic' nonlocality of nature! Could the inherently nonlocal structure of quantum theory (e.g., non-separability, relationality, or holism) imply that the empirical reality it accounts for is intrinsically nonlocal as well? It is well-known that orthodox, operationalist quantum mechanics vigorously denies fundamental interconnectedness: the orthodox position (e.g., Copenhagen) holds that only exclusively local phenomena could have existence in any physical sense; central tenets of orthodox quantum mechanics would otherwise be violated, i.e., intrinsic randomness and the non-signalling constraint.

By contrast, non-orthodox, realistic quantum mechanics as exemplified by de Broglie-Bohm theory, has long postulated the (ontic) existence of instantaneous, nonlocal influences (Bohm, 1952ab). Crucially, in realistic quantum mechanics the observed 'quantum randomness' need not be viewed as evidence for the rule in nature of 'objective chance' but as evidence only for the 'in-principle unpredictability' of individual quantum events. This is the case even when these events are governed by deterministic relations. In the realistic quantum mechanics of Bohm, individual quantum events, we propose, represent strictly 'emergent events'. The chief characteristic of emergence, self-organization, or complexity, theory is its account of the appearance of novel, unpredictable outcomes based upon entirely deterministic relations. Put simply, the concept of emergence represents a concept of "determinism without pre-determinism": an 'indefinite ontic structure' (IOS) becomes a 'definite ontic structure' (DOS) as a result of new boundary conditions.

Therefore, the development of an "emergent quantum mechanics" (EmQM), as envisioned here, calls for research into the microscopic processes manifesting IOS-DOS transitions, a form of "quantum reality without pre-determination" ensuring free will of the observer/agent in science.

Does Bell's theorem (Bell, 1964) imply necessarily the impossibility of instantaneous nonlocal influences, i.e., of those influences which Bohr and Einstein denied so vehemently? To the contrary, it is well-established that Bell himself, like Bohm, was a realist about quantum mechanics, and that he maintained a strong interest in Bohm's theory even long after publishing his seminal proof. Since Bell and Bohm were unified on the concept of "reality without pre-determination", even at the level of the quantum, both can be considered foundational pioneers of the EmQM project. Finally, it is highly likely that – assuming nonlocality – the possibility of an EmQM will depend on breakthroughs in our understanding of space-time itself as an emergent phenomenon. Fact is, an increasing number of physicists are convinced that space is an emergent, not fundamental, concept, as exemplified in new approaches such as 'emergent gravity'. "Emergence" may stand central in unification efforts.

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1,2 This work is funded in part by the Fetzer Franklin Fund of the John E. Fetzer Memorial Trust.

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Jan Walleczek Ph.D. is Director of the Fetzer Franklin Fund, and a Trustee of the John E. Fetzer Memorial Trust. He lives in Berlin, Germany, where he founded Phenoscience Laboratories. Previously he was Director of the Bioelectromagnetics Laboratory at Stanford University Medical School, Palo Alto, California. Jan Walleczek studied biology at the University of Innsbruck in Austria, followed by doctoral work at the Max-Planck-Institute for Molecular Genetics in Berlin, and post-doctoral work at the Research Medicine and Radiation Biophysics Division of the Lawrence Berkeley National Laboratory, University of California at Berkeley.

His research interests are diverse, and his scientific publications cover the fields of biology, chemistry, engineering, and physics. His work focuses on the foundations of quantum mechanics and the application to living systems of concepts such as quantum coherence, emergent dynamics, and the flow of information, a long-standing interest that he summarized as an edited volume for Cambridge University press titled “Self-organized biological dynamics and nonlinear control”. In addition to metascience and advanced research design, his professional interests include the philosophy and the foundations of science.

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Jeff Tollaksen is a Professor of Physics and Director of the Center for Excellence in Quantum Studies at Chapman University. He received his BA in physics from MIT. He later attended Boston University where he earned a MA and PhD in theoretical physics.

Before teaching at Chapman University, Tollaksen worked in the School of Computational Science at George Mason University. He has published over a dozen articles in various scientific journals and has conducted research via five grants on which he is the prime investigator.

(source: Chapman University)

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THE QUANTUM PIGEONHOLE PRINCIPLE AND LOCALIZING KOCHEN-SPECKER CONTEXTUALITY WITH WEAK MEASUREMENTS

Jeff Tollaksen Vienna University of Technology

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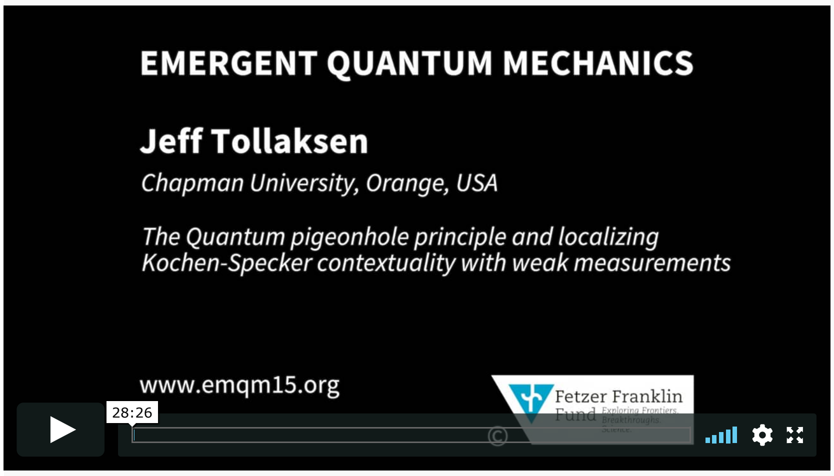

The pigeonhole principle: “If you put three pigeons in two pigeonholes at least two of the pigeons end up in the same hole” is an obvious yet fundamental principle of Nature as it captures the very essence of counting. However we have showed that in quantum mechanics this is not true! We find instances when three quantum particles are put in two boxes, yet no two particles are in the same box. Furthermore, we show this is only one of a host of related quantum effects and that it points to a very interesting structure of quantum mechanics that was hitherto unnoticed. Our results shed new light on the very notions of separability and correlations in quantum mechanics and on the nature of interactions. It also presents a new role for entanglement, complementary to the usual one.
Finally, I review how weak values and weak measurements represent a new class of experiments to test quantum contextuality. We have showed that using pre- and post-selected states along with many existing proofs of the Kochen-Specker theorem, it is possible to localize the violation of noncontextuality to specific observables where it can be probed using weak measurements. We have analyzed several important Kochen-Specker examples in detail, and introduced a framework for a more general set of experimental tests based on known proofs of the Kochen-Specker theorem. The underlying ontological models that are used in these arguments are explored detail, and connections are made to pre- and post-selected state paradoxes such as the 3-box paradox, the quantum Cheshire Cat, and the quantum pigeonhole principle, as well as to the Mean King’s problem.

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FIELD-THEORY REVOLUTION FOR OPTICS: REVISITING MOMENTUM AND ANGULAR MOMENTUM OF LIGHT

Konstantin Bliokh

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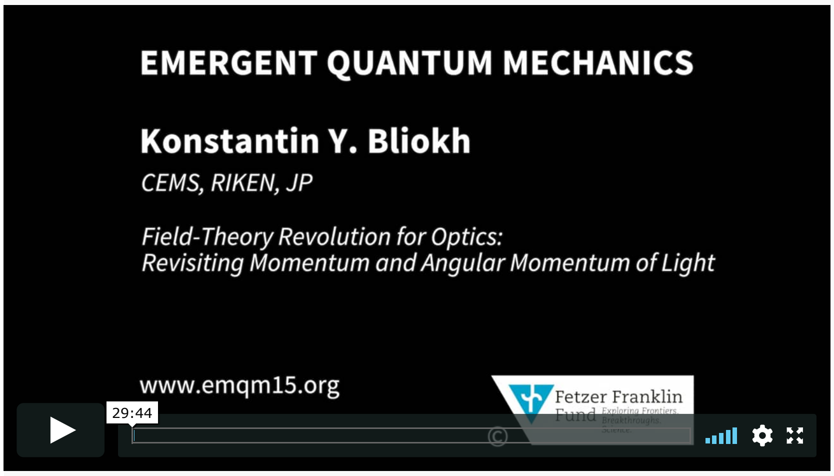

I will overview recent theoretical and experimental studies, which revisit fundamental dynamical properties of light: momentum, angular momentum, and helicity. I will show that the commonly accepted approach based on the use of the Poynting vector and the corresponding angular momentum does not work well for optical fields and laboratory experiments. An alternative approach requires revisiting the electromagnetic field theory and its connection with optics and quantum mechanics. It turns out that the canonical (rather than kinetic) field-theory picture of gauge-dependent momentum and spin densities of the massless electromagnetic field is perfectly consistent with the laboratory optical experience, provided that the Coulomb gauge is chosen.
The above analysis is not of purely theoretical interest. This new 'canonical' approach to the momentum, spin, and helicity of light has allowed us to predict qualitatively new types of the spin and momentum in structured optical fields. These are:
1. The transverse spin angular momentum, which is orthogonal to the wave vector and is independent of the helicity;
2. The anomalous transverse momentum, which depends on the helicity of light and exerts a weak anomalous optical pressure orthogonal to the wave vector.
Both these quantities have attracted considerable attention and have been described and measured experimentally in several optical systems. I will overview these new findings and experiments.

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Lajos Diósi

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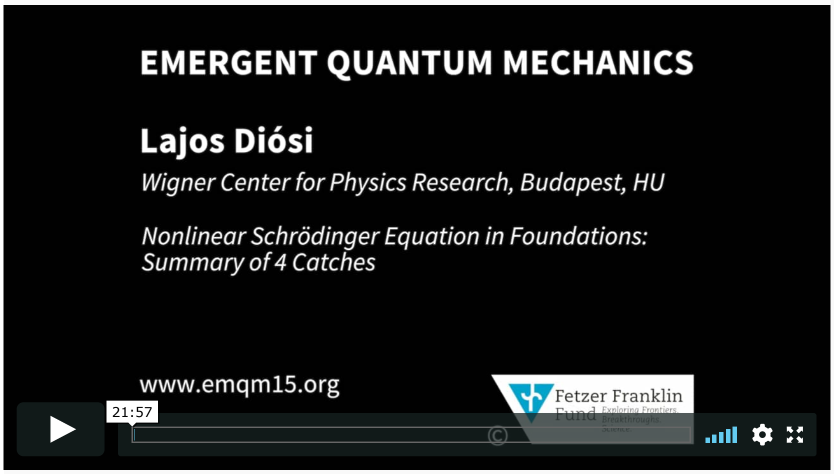

Fundamental modifications of the standard Schrödinger equation by additional nonlinear terms have been considered for various purposes over the recent decades. It came as a surprise when, inverting Abner Shimonyi's observation of "peaceful coexistence" between standard quantum mechanics and relativity, N. Gisin proved in 1990 that any (deterministic) nonlinear Schrödinger equation would allow for superluminal communication. This is by now the most spectacular and best known foundational anomaly. I am going to discuss further anomalies, simple but foundational, less spectacular but not less dramatic.

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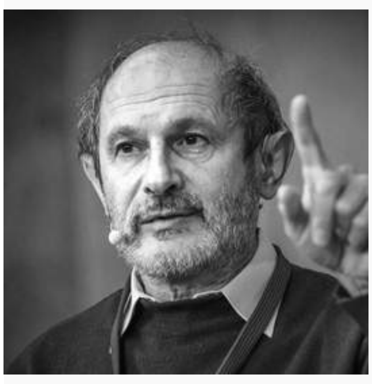

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2000 Doctor of Academy (Hungarian Academy of Sciences)
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2008 Member of Editorial Advisory Board, The Open Nuclear & Particle Physics Journal
2008 Lady Davies Visiting Professorship (Technion, Israel)
1999 Member of Institute for Advanced Study (Berlin, Wissenschaftskolleg)
1997 Visiting Professor (QMW College, London University)
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2000 scientific advisor, High Energy Physics Department
1988 senior research associate, High Energy Physics Department
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1976 co-worker, Computer Technics Department,
1973 postgraduate position, High Energy Physics Department
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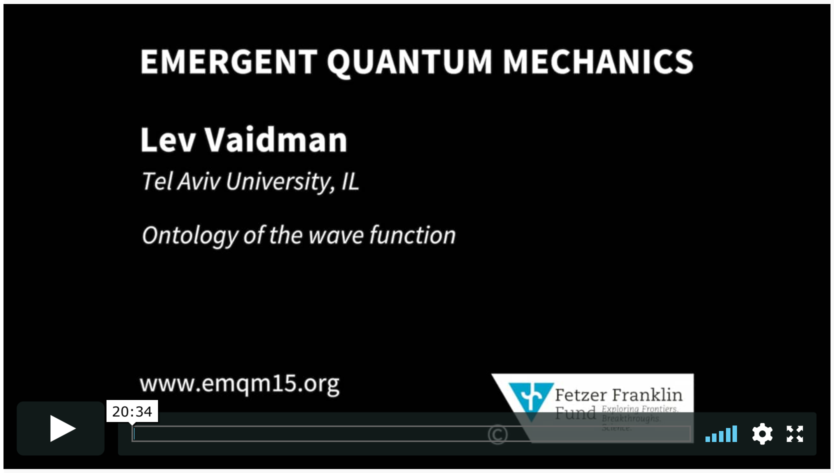

I will argue that the picture in which the only ontological concept in description of Nature is the universal wave function is consistent with our experience(s). Although formally, the wave function is defined in the configuration space of positions of all particles, the decomposition of the wave function to superposition of components described in 3-space is what provides the connection to our experience. The role of the wave function evolving backward in time will be explained.

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Profile

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The main research of Lev Vaidman is in the fields of Foundations of Quantum Mechanics and Quantum Information.

Most of his works belong to theoretical physics, but he also performs some experimental work in quantum optics and writes philosophical papers on the many-worlds interpretation of quantum mechanics.

His main contributions are variants of quantum measurements: interaction-free measurements (the Elitzur-Vaidman bomb problem), protective measurements, weak measurements (the Aharonov-Albert-Vaidman Effect), non-local measurements (which led to discovery of teleportation of continuous variables).

In the area of Quantum Information he invented a secret key distribution with quantum particles in orthogonal states (the Goldenberg-Vaidman protocol), quantum gambling, and practically secure bit commitment.

The main tool of his research is the analysis of paradoxes such as the 3-box paradox, the paradox of a photon being at a place through which it cannot pass and more. The Paradoxes help him achieve the goal of deeper understanding of locality and randomness in Nature.

(source: Tel Aviv University)

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EPR PARADOX, QUANTUM NONLOCALITY AND PHYSICAL REALITY

Marian Kupczynski

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Eighty years ago Einstein, Podolsky and Rosen demonstrated that the instantaneous reduction of wave function describing a couple of entangled physical systems led to so called EPR paradox. The paradox disappears in statistical interpretation of Quantum Theory (QT) according to which a quantum state does not describe completely an individual physical system but only an ensemble of identically prepared physical systems. Quantum probabilities are not degrees of belief of some intelligent agents but they are objective properties of physical experiments which might emerge from some more detailed description of quantum phenomena. QT predicts strong correlations between the outcomes of measurements performed on different members of EPR pairs in far-away locations. Searching for an intuitive explanation of these correlations John Bell analysed so called local realistic hidden variable models and proved that these models always satisfy Bell inequalities which are violated by the predictions of QT. Several different local models were constructed and inequalities proven. Some eminent physicists concluded that Nature is definitely nonlocal and that it is acting according a new law of nonlocal randomness. According to this law perfectly random, but strongly correlated events, can be produced at the same time at far away locations and a spatio-temporal, local and causal explanation of their occurrence cannot be given. We strongly disagree with this conclusion and in this talk we analyse various finite sample proofs of Bell and CHSH inequalities and so called Quantum Randi Challenges. We will also show how one can win so called Bell's game without violating locality of Nature. Nonlocal randomness is inconsistent with local quantum field theory, with standard model in elementary particle physics and with causal laws and adaptive dynamics prevailing in the surrounding us world. The experimental violation of Bell-type inequalities does not prove the nonlocality of Nature but it only confirms the contextuality and complementarity of quantum observables and gives a strong argument against the point of view according to which the experimental outcomes are produced in irreducible random way. Time permitting we will explain "sample homogeneity loophole" which could not be closed in several experiments testing local realism.

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4. Kupczynski, M, Significance tests and sample homogeneity loophole, arXiv:1505.06349 [quant-ph]

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• High energy scattering. Possibility of the violation of the optical theorem in spite of the unitarity of S matrix.

• Search for the experimental evidence of the violation of the optical theorem in high energy hadron-hadron scattering in LHC.

• Statistical analysis of the experimental data. Non parametric compatibility tests (purity tests). Search for the fine structures

in time- series of data.

• Predictions of the quark model for the scattering of polarized initial beams. (Ph.D. Thesis and related publications).

• Group theory. Contractions of Lie groups and their representations. (M.Sc. Thesis and related publications)

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Markus Arndt (* 14. September 1965 in Unkel) ist ein deutscher Physiker und Professor für Quantennanophysik an der Universität Wien.
Markus Arndt studierte von 1985 bis 1990 Physik in Bonn und München. Es folgten von 1991 bis 1994 Doktoratsstudien am Max-Planck-Institut für Quantenoptik in Garching; das Thema der Dissertation lautete Optical and magneto-optical spectroscopy of metal atoms in liquid and solid He-4. Von 1994 bis 1995 war Arndt wissenschaftlicher Mitarbeiter am Max-Planck-Institut für Quantenoptik, von 1999 bis 2002 Universitätsassistent am Institut für Experimentalphysik der Universität Wien, ebenda erfolgte 2002 seine Habilitation. Ab September 2004 war er Vertragsprofessor für Quantennanophysik an der Universität Wien. 2008 wurde er Universitätsprofessor für Quantennanophysik an der Fakultät für Physik der Universität Wien.
Markus Arndt ist verheiratet und hat zwei Söhne.

Im Jahr 2000 erhielt er den Erich-Schmid-Preis der österreichischen Akademie der Wissenschaften (ÖAW), gemeinsam mit G. Springholz, sowie den Fritz-Kohlrausch Preis der Österreichischen Physikalischen Gesellschaft (ÖPG). Im Jahr 2001 wurde er mit dem START-Preis des Fonds zur Förderung der wissenschaftlichen Forschung (FWF) ausgezeichnet, 2008 mit dem FWF Wittgensteinpreis Wittgensteinpreis. 2012 warb er einen Advanced Grant des Europäischen Forschungsrats (ERC) ein [3]. Im Jahr 2013 wurde ihm der Preis der Stadt Wien für Naturwissenschaften zuerkannt. 2014 wurde er zum korrespondierenden Mitglied im Inland der mathematisch-naturwissenschaftlichen Klasse der Österreichischen Akademie der Wissenschaften gewählt.

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QUANTUM OPTICS WITH NANOBIOLOGICAL MATTER

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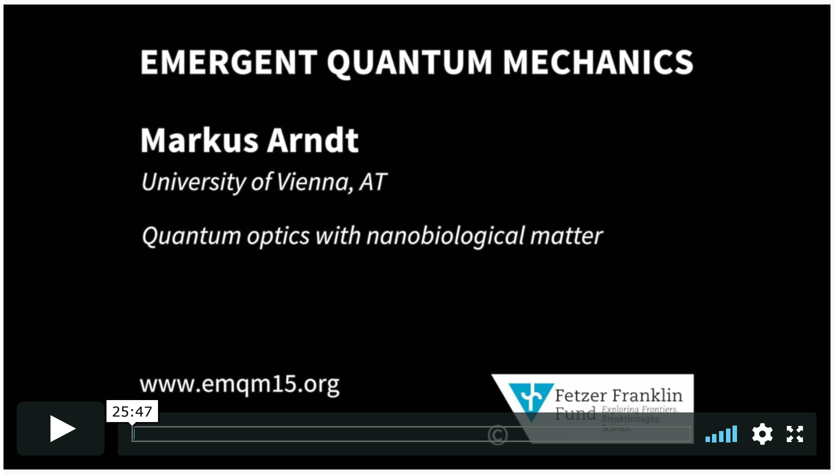

Quantum physics is the uncontested best description of the inanimate world but it leads to phenomena which are often in conflict with our common perception of the world. This conundrum is exemplified by Schrödinger's thought experiment of a cat being dead and alive. We now ask how far we can push the idea. What mass may an object have and still be in a quantum superposition of several classically distinct states? How does the internal state of complex particles influence the quantum coherent dynamics in the presence of realistic beam splitters? How can we protect a molecule with biological functionality during state of the art quantum experiments such that it maintains biological functionality even beyond these experiments?

We will show quantum superposition experiments with a diverse set of biological nanomatter, such as vitamins, biomolecular clusters and biodyes. We present progress in experiments with amino acids and polypeptides and discuss the challenges and progress towards quantum interference studies with proteins and self-replicating molecules.

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MEASUREMENTS ON THE REALITY OF THE WAVEFUNCTION

Martin Ringbauer Vienna University of Technology

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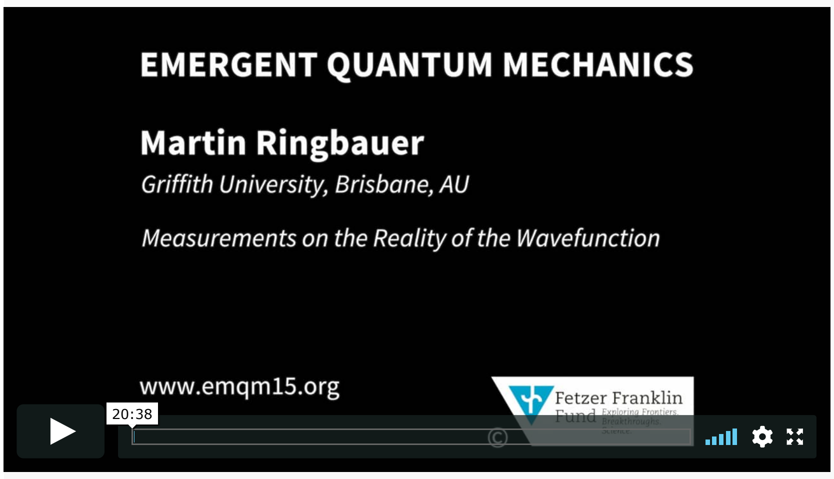

The quantum wavefunction is at the heart of our best description of nature, yet we don't know what this object actually represents. Does it correspond to physical reality (the psi-ontic interpretation), is a representation of knowledge or information about an underlying reality (the psi-epistemic interpretation) or is there no reality at all and the wavefunction just represents our subjective experience? The psi-epistemic viewpoint appears very compelling in that it offers intuitive and simple explanations for many puzzling quantum phenomena. Whether it is indeed compatible with quantum mechanics and the notion of objective observer-independent reality has, on the other hand, long been an open question. We have recently demonstrated experimentally that no realist psi-epistemic model can fully explain the imperfect distinguishability of non-orthogonal quantum states – one of the fundamental features of the theory. In contrast to the no-go theorems of Pusey, Barrett, Rudolph and others, our experiment requires no fundamental assumptions such as a specific structure of the underlying ontic state space. Our results thus suggest that maintaining objective observer-independent reality requires a psi-ontic interpretation. Alternatively one could give up objective reality, or reject the ontological model framework and consider more exotic alternatives, such as retrocausal influences. Indeed, Bell's famous theorem already shows that our classical notion of causality is incompatible with quantum mechanics and well-established causal discovery methods fail to produce conclusive results in the face of Bell-inequality scenarios. We explore relaxations of Bell's assumptions as a possible way to recover a causal explanation of Bell correlations and test hidden variable models beyond Bell's theorem.

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Reference

Ringbauer, M., Duffus, B., Branciard, C., Cavalcanti, E. G., White, A. G., Fedrizzi, A. (2015) Measurements of the Reality of the Wave Function. Nature Phys. 11, 249-254.

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MATT LEIFER

Institute for Quantum Studies and Schmid College of Science and Technology, Chapman University

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Matt Leifer is an academic who straddles the line somewhere between mathematics, philosophy, and theoretical physics. His main interests are in Quantum Information Theory and the Foundations of Quantum Theory.

He received his bachelors degree in Physics with Theoretical Physics from The University of Manchester in 1999, followed by a Masters of Advanced Study in Mathemaics (Maths Tripos part III) from the Department of Applied Maths and Theoretical Physics at the University of Cambridge in 2000, where he was a member of Girton College.

He studied for my Ph.D. in the School of Mathematics at the Univeristy of Bristol (2000-2003) under the supervision of Prof. Noah Linden, where I was a member of the Quantum Computing Group.

After a brief stint as a research assistant at Bristol, he arrived at Perimeter Institute as a Postdoctoral Fellow in January 2004, where he worked until September 2006. From October 2006, he was a research associate in the Centre for Quantum Computation at the University of Cambridge for three months. In January 2007, he arrived back in Waterloo for a second postdoctoral position, in which he was affiliated with the Institute for Quantum Computing and the Department of Applied Math at the University of Waterloo, and with the Perimeter Institute. The latter was due to a research grant from the Foundational Questions Institute.

Between April 2008 and August 2010, he was on leave of absence from work due to illness, after which he returned to work on a part time basis at University College London in the Quantum Information Group of the Physics and Astronomy department. Between December 2011 and August 2013, he was off work again due to illness. Since August 2013, he has returned to the Perimeter Institute as a long term visitor.

(source: Chapman University)

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THE REALITY OF THE QUANTUM STATE FROM KOCHEN-SPECKER CONTEXTUALITY

Matt Leifer Vienna University of Technology

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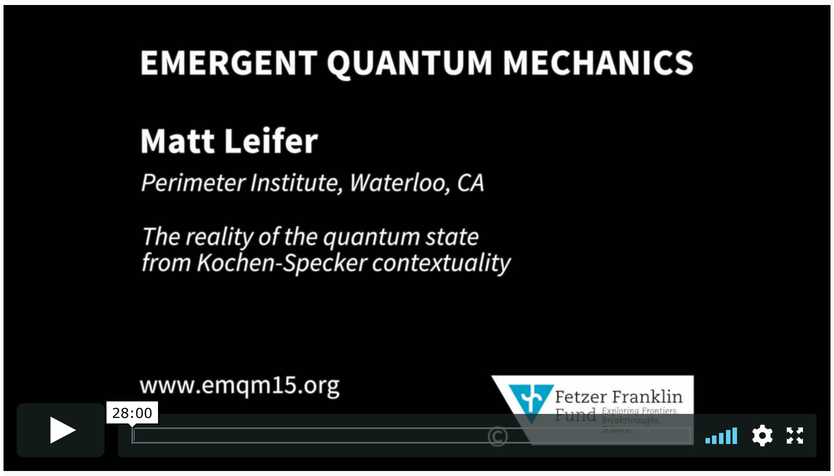

The stated aim of this conference is “the open exploration of the quantum state as a reality”, but, as a curmudgeon, I would prefer to first establish whether the quantum state actually needs to be real. After all, there are many advantages to viewing the quantum state as epistemic (a state of knowledge, information, or belief) instead. For example, the fact that nonorthogonal quantum states cannot be distinguished is puzzling if they represent distinct states of reality, but unsurprising if they are more analogous to overlapping probability distributions. In this talk, I will review recent progress on rigorously establishing the reality of the quantum state. After a quick review of early results like the Pusey-Barrett-Rudolph theorem, I will focus on more recent work that does not make additional assumptions beyond our basic framework for realist theories (the ontological models framework). This framework assumes that there is some objective state of reality, and that quantum states correspond to probability distributions over them. Although it is impossible to prove that quantum states must be real in this framework without additional assumptions, it is possible to show that the amount of overlap of the probability distributions is much too small to account for the lack of distinguishability of quantum states. I will review the “overlap bounds” that have been proved along these lines and show that they can all alternatively be derived from proofs of Kochen-Specker contextuality. I will discuss experiments to test these bounds and, if time permits, show how the connection to contextuality allows for a unified treatment of experimental errors.

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Profile

MAURICE DE GOSSON

University of Vienna, Faculty of Mathematics, NuHAG

Maurice A. de Gosson also known as Maurice Alexis de Gosson de Varennes is an Austrian mathematician and mathematical physicist, born in 1948 in Berlin. He is currently a Senior Researcher at the Numerical Harmonic Analysis Group (NuHAG) of the University of Vienna.

After completing his PhD in microlocal analysis at the University of Nice in 1978 under the supervision of Jacques Chazarain, de Gosson soon became fascinated by Jean Leray's Lagrangian analysis. Under Leray's tutorship de Gosson completed a Habilitation à Diriger des Recherches en Mathématiques at the University of Paris 6 (1992). During this period he specialized in the study of the Leray-Maslov index and in the theory of the metaplectic group, and their applications to mathematical physics. In 1998 de Gosson met Basil Hiley, who triggered his interest in conceptual question in quantum mechanics. Basil Hiley wrote a foreword to de Gosson's book The Principles of Newtonian and Quantum Mechanics (Imperial College Press, London). After having spent several years in Sweden as Associate Professor and Professor in Sweden, de Gosson was appointed in 2006 at the Numerical Harmonic Analysis Group of the University of Vienna, created by Hans Georg Feichtinger (see www.nuhag.eu). He currently works in symplectic methods in harmonic analysis, and on conceptual questions in quantum mechanics, often in collaboration with Basil Hiley.

Maurice de Gosson has held longer visiting positions at Yale University, University of Colorado in Boulder (Ulam Visiting Professor), University of Potsdam, Albert-Einstein-Institut (Golm), Max-Planck-Institut für Mathematik (Bonn), Université Paul Sabatier (Toulouse), Jacobs Universität (Bremen).

Maurice de Gosson was the first to prove that Mikhail Gromov's symplectic non-squeezing theorem (also called „the Principle of the Symplectic Camel") allowed the derivation of a classical uncertainty principle formally totally similar to the Robertson-Schrödinger uncertainty relations (i.e. the Heisenberg inequalities in a stronger form where the covariances are taken into account). This rather unexpected result was discussed in the media.

In 2004/2005, de Gosson showed that Gromov's non-squeezing theorem allows a coarse graining of phase space by symplectic quantum cells, each described by a mean momentum and a mean position. The cell is invariant under canonical transformations. De Gosson called such a quantum cell a quantum blob: *"The quantum blob is the image of a phase space ball with radius by a (linear) symplectic transformation"* and *"Quantum blobs are the smallest phase space units of phase space compatible with the uncertainty principle of quantum mechanics and having the symplectic group as group of symmetries. Quantum blobs are in a bijective correspondence with the squeezed coherent states from standard quantum mechanics, of which they are a phase space picture."*

Their invariance property distinguishes de Gosson's quantum blobs from the "quantum cells" known in thermodynamics, which are units of phase space with a volume of the size of Planck's constant h to the power of 3.

De Gosson's notion of quantum blobs has given rise to a proposal for a new formulation of quantum mechanics, which is derived from postulates on quantum-blob-related limits to the extent and localization of quantum particles in phase space; this proposal is strengthened by the development of a phase space approach that applies to both quantum and classical physics, where a quantum-like evolution law for observables can be recovered from the classical Hamiltonian in a non-commutative phase space, where x and p are (non-commutative) c-numbers, not operators.

(source: Wikipedia)

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WEAK VALUES AND THE RECONSTRUCTION PROBLEM IN BORN-JORDAN QUANTIZATION

Maurice de Gosson

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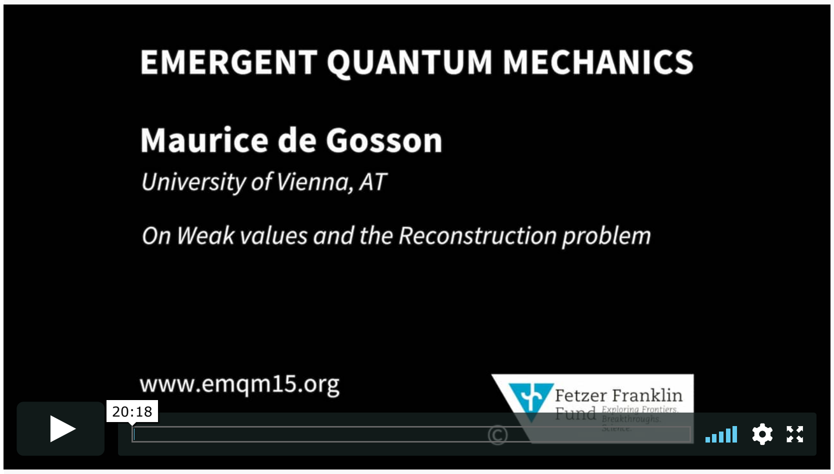

Some time ago Lundeen et al. (Nature 474, 188-99, 2011) have shown how to reconstruct the wavefunction ψ (x) by scanning the weak measurements of the projection operator on x. We show that, more generally, if one works in the Weyl formalism, the post-selected state ψ can easily be reconstructed from the knowledge of the cross-Wigner transform W(ψ,φ) and of the pre-selected state φ (and vice-versa); Lundeen's result is then obtained as a particular case of our formula. Mathematical difficulties however occur when one replaces Weyl quantization by the more physical Born-Jordan quantization. We expose some of these difficulties in the presenttalk, and briefly discuss the example of the squared angular momentum.

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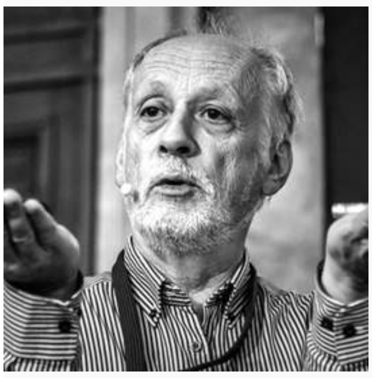

Professor Nicolas Gisin was born in Geneva, Switzerland, in 1952. After a master in physics and a degree in mathematics, he received his Ph.D. degree in Physics from the University of Geneva in 1981 for his dissertation in quantum and statistical physics. The "Fondation Louis de Broglie" recognised this work with an award.

After a post-doc at the University of Rochester, NY, he joint a start-up company, Alphatronix, dedicated to fiber instrumentation for the telecommunication industry. Initially head of the software, he quickly became responsible for the hardware-software interface. Four years later he joined a Swiss software company developing an image processing package which received the attention of the American journal "PC Magazine".

In 1988 an opportunity to join the Group of Applied Physics at the University of Geneva as head of the optics section brought him back to the academic life. At the time the optics section was entirely devoted to support of the Swiss PTT (now Swisscom). In order to get a critical mass and stability, the optics section under the impulse of Prof. N. Gisin started two new research directions, one in optical sensors, one in quantum optics. The telecom and the sensing activities led to many patents and technological transfers to Swiss and international industries. Several products had and still have a commercial success. The quantum optics activities are more basic research oriented. The main theme is to combine the large expertise of the group in optical fibers with basic quantum effects. More recently, the demonstration of quantum cryptography and of long distance quantum entanglement received quite a lot of attention as well from the international scientific community as from the press "grand public".

In 2009, he was awarded the First Biennial John Stewart Bell Prize for Research on Fundamental Issues in Quantum Mechanics and their Applications.

(source: Université de Genève)

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QUANTUM CORRELATIONS IN NEWTONIAN SPACE AND TIME: ARBITRARILY FAST COMMUNICATION OR NONLOCALITY

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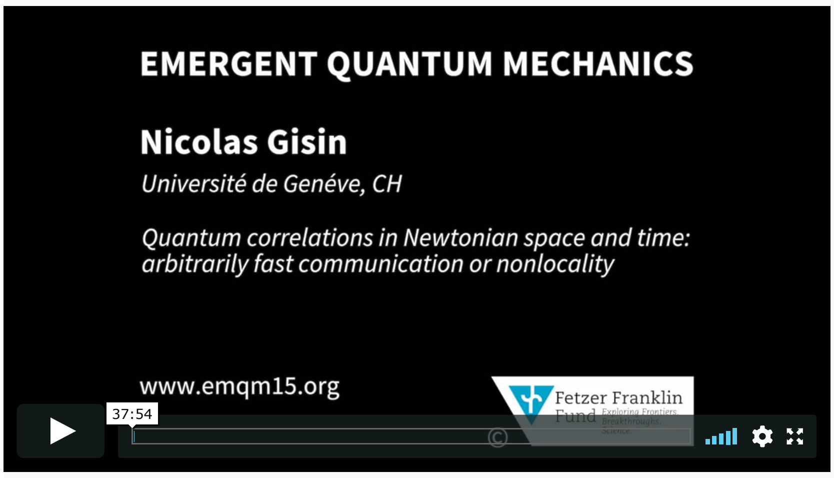

Experimental violations of Bell inequalities using space-like separated measurements precludes the explanation of quantum correlations through causal influences propagating at subluminal speed. Yet, "everything looks as if the two parties somehow communicate behind the scene". We investigate the assumption that they do so at a speed faster than light, though finite. Such an assumption doesn't respect the spirit of Einstein relativity. However, it is not crystal clear that such "communication behind the scene" would contradict relativity. Indeed, one could imagine that this communication remains for ever hidden to humans, i.e. that it could not be controlled by humans, only Nature exploits it to produce correlations that can't be explained by usual common causes. To define faster than light hidden communication requires a universal privileged reference frame in which this faster than light speed is defined. Again, such a universal privileged frame is not in the spirit of relativity, but it is also clearly not in contradiction: for example the reference frame in which the cosmic microwave background radiation is isotropic defines such a privileged frame. Hence, a priori, a hidden communication explanation is not more surprising than nonlocality.
We prove that for any finite speed, such models predict correlations that can be exploited for faster-than-light communication. This superluminal communication doesn't require access to any hidden physical quantities, but only the manipulation of measurement devices at the level of our present-day description of quantum experiments. Consequently, all possible explanations of quantum correlations that satisfy the principle of continuity, which states that everything propagates gradually and continuously through space and time, or in other words, all combination of local common causes and direct causes that reproduce quantum correlations, lead to faster than light communication. Accordingly, either there is superluminal communication or the conclusion that Nature is nonlocal (i.e. discontinuous) is unavoidable [Nature Physics 8, 867-70, 2012; arXiv:1210.7308].

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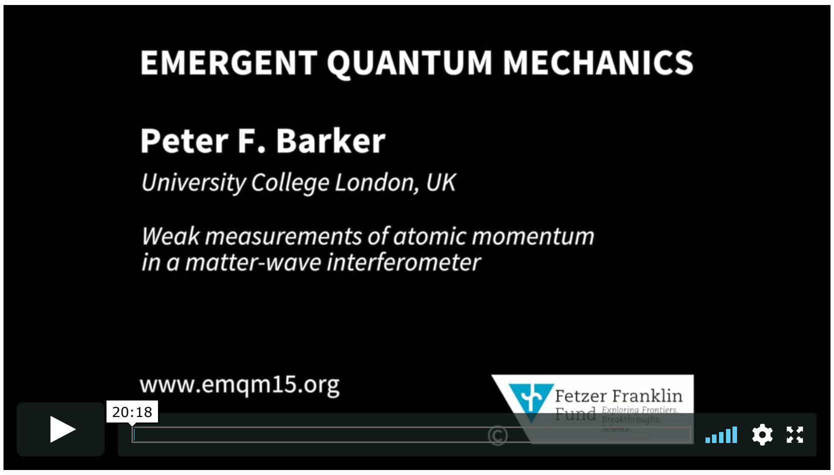
WEAK MEASUREMENTS OF ATOMIC MOMENTUM IN A MATTER-WAVE INTERFEROMETER

Peter Barker



There is currently considerable interest in the use of weak measurements, first introduced by Aharonov, Albert and Vaidman[1], to explore fundamental quantum processes and for quantum metrology. Of particular impact has been the experiment of Kocsis et al. [2] that employed weak measurements of photon momentum followed by a strong measurement of position to reconstruct average trajectories of photons . Here, the polarization of the photon was used as a pointer that weakly coupled to the transverse photon momentum. To date this type of experiment has only been performed on photons, of which a classical wave optics interpretation can be also applied [3].

In this presentation I will describe the development of a two-slit, matter-wave interferometer that uses non-relativistic particles (argon atoms) to perform weak measurements of momentum. Here, the pointer that weakly couples to momentum is the spin of the 5 Zeeman states of the laser cooled metastable (4S[3/2]2) argon atoms which are dropped through two slits formed within a metallic film. This experiment will also allow the reconstruction of average trajectories of the atoms within the interferometer, but unlike the interference of photons, this effect can only be described by a quantum analysis.

[1] Y. Aharonov, D. Z. Albert, L. Vaidman, Phys. Rev. Lett. 60, 1351 (1988)

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PETER BARKER

Department of Physics and Astronomy, University College London

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Peter Barker got a background in atomic and molecular laser spectroscopy, non-linear optics, and laser trapping and cooling. Within the last 10 years his research has concentrated on the study of molecular cooling and trapping and on quantum cavity optomechanics. He has expertise in developing applications from more basic optical physics research.

He was awarded a PhD in Physics from the University of Queensland, Australia in 1996. From 1997 to 2001 he was a Postdoctoral Research Associate, and then a Research Scientist and Lecturer in the Applied Physics Group in the Mechanical and Aerospace Engineering Department at Princeton University. At Princeton, I began to study the manipulation of atoms and molecules in pulsed optical fields by studying coherent Rayleigh scattering from molecules trapped in optical lattices. During his time he was part of a multidisciplinary team of physicists and engineers from Princeton University, Sandia National Laboratories and Lawrence Livermore developing a new type of wind tunnel for accelerating gases to hypersonic speeds using lasers and electron beams. In 2001 he took up the position of Lecturer in the Physics Department at Heriot-Watt University and became a Senior Lecturer in 2004. In October 2006 he joined the AMOP group at UCL as a Reader and was promoted to Professor in October 2007. Currently he has projects in cavity optomechanics using nanoparticles levitated in vacuum and larger microscale clamped systems based on whispering gallery mode resonators for studying fundamental quantum mechanics and for development of sensors.

(source: University College London)

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MEASURING THE WEAK VALUE OF ATOMIC SPIN

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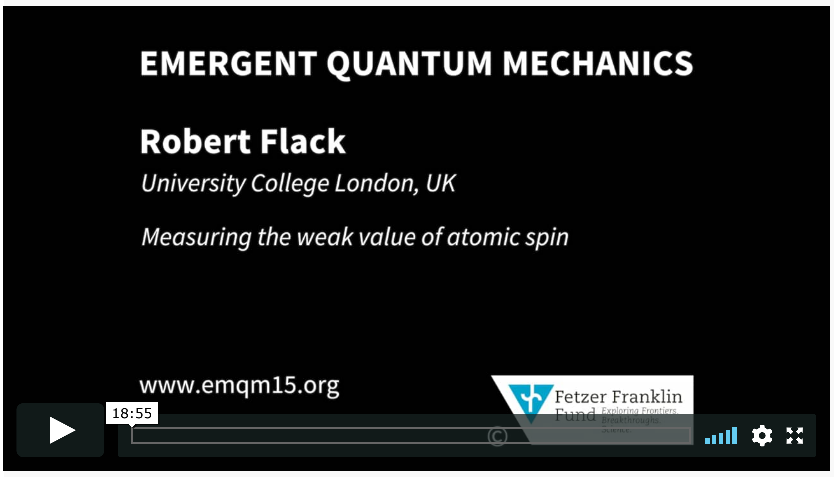

The idea of a weak value has been brought to prominence by Aharonov, Albert and Vaidman [1]. Measuring a weak value can reveal more details of quantum processes than is possible with the traditional Von Neumann (strong) measurement [2] which is a single stage process where the wave function collapses. In contrast the weak measurement process has three stages; preselection, weak stage and finally a post selection.
Although it has been observed using photons and neutrons, weak measurement has not yet been demonstrated for atoms obeying the Schrödinger equation (Schrödinger particles).
We are following the method outlined by Duck et al [3] which is a variant on the original Stern-Gerlach experiment. We are using a metastable, 23S1, form of helium which has three spin angular momentum states of +1; 0; -1, a magnetic dipole moment with a magnitude of two Bohr Magnetons [4] [5] and a lifetime of approximately 8000 seconds [6]. Although this metastable state has three substates we will only use the +1 states. The design and realisation of the experiment will be presented.

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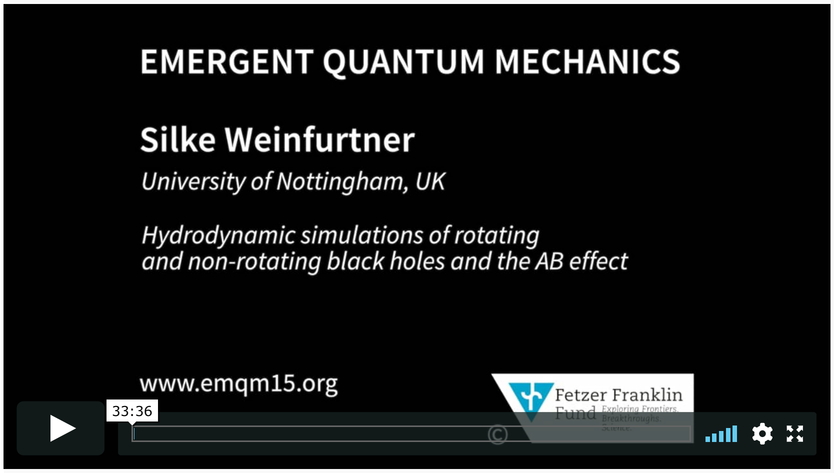
HYDRODYNAMIC SIMULATIONS OF ROTATING AND NON-ROTATING BLACK HOLES

Silke Weinfurtner



There is an analogy between the propagation of fields in the vicinity of astrophysical black holes and the that of small excitations in fluids and superfluids. This analogy allows one to test, challenge and verify, in tabletop experiments, the elusive processes of black hole mass and angular momentum loss.

I will first present a brief overview on analogue black hole experiments, and then discuss in more detail some of my earlier and more recent experimental and theoretical results on the subject.

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Participation

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Profile

SILKE WEINFURTNER

University of Nottingham, UK

Prizes and Awards

05/2013 Royal Society University Research Fellowship (UK), 598.062 GBP

05/2013 Notthingham Advanced Research Fellowship (UK), 217.163 GBP

05/2013 Vidi award (Netherlands), 800.000 EUR

09/2012-08/2013 SISSA Research Award for Young Scientists

2011 / 2012 ERC-2012-StG invitation to Step 2 (including interview in Brussels)

09/2011-08/2014 Marie Curie Actions – Career Integration Grant (CIG)

05/2011-10/2012 SISSA Research Award for Young Scientists

11/2010 Invitation to become an FQXi member

09/2008-09/2011 Marie Curie Actions – International Outgoing Fellowships (IOF)

2006 Victoria University PhD completion scholarship

2005 New Zealand Postgraduate Study Abroad Award

10/2004-10/2005 DAAD partial stipend for overseas studies

09/2004 Hartle Prize of the International Society on GR and Gravitation for student presentation

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Hydrodynamic simulations of rotating and non-rotating black holes

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Silke Weinfurtner on understanding the mysteries of black holes: build a big bathtub

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SPEAKER
Thanu Padmanabhan

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ATOMS OF SPACETIME AND THE NATURE OF GRAVITY

Thanu Padmanabhan

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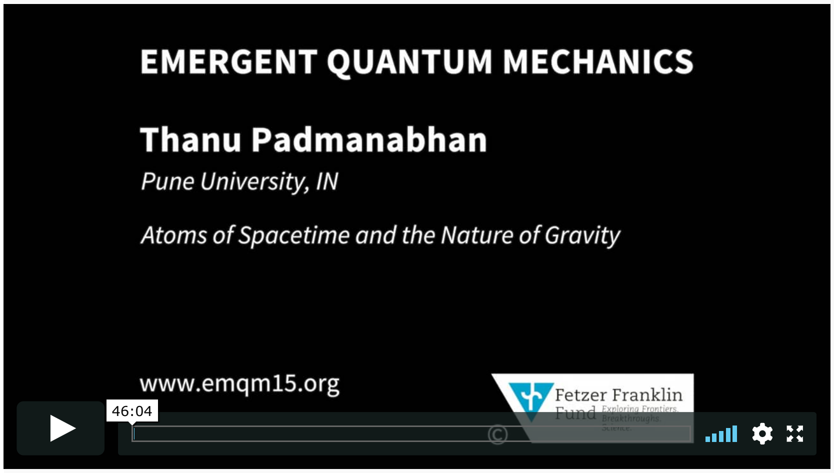

A natural guiding principle for gravitational dynamics is that the field equations of gravity should remain invariant when a constant is added to the Lagrangian. This principle uniquely selects the Lanczos-Lovelock models of gravity in D dimensions and Einstein's theory in D=4. More importantly, it leads to a thermodynamic interpretation for several variables (usually considered to be geometrical) as well as for the equation describing the spacetime evolution. Extending these ideas one level deeper, I show how the relevant thermodynamic variational principle can be obtained from a distribution function for the number density of the "atoms of spacetime". This is based on the curious fact that the renormalized spacetime endows each event with zero volume but finite area!

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Profile

THANU PADMANABHAN

Pune University, IN

Professor Thanu Padmanabhan is an internationally acclaimed Theoretical Physicist and Cosmologist whose research spans a wide variety of topics in Gravitation, Structure formation in the universe and Quantum Gravity. He has published more than 240 papers and reviews in international journals and nine books in these areas. Many of his contributions, especially those related to the analysis and modeling of dark energy in the universe and the thermodynamics of spacetime horizons, have made significant impact in the field.

He was honoured with a Padma Shri by the President of India in 2007.

Born in 1957, Padmanabhan took his B.Sc. and M.Sc. degrees in Physics from Kerala University and was a Gold medallist in both. Subsequently he joined TIFR, Mumbai where he did his Ph.D. in Physics. He held various positions at TIFR during 1980-1992 and also spent a year (in 1986-87) at the Institute of Astronomy, Cambridge for his postdoctoral research. He moved to the Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune in 1992 and became Dean, Core Academic Programmes of that Centre in 1997, which is the position he is currently holding. He has been a visiting faculty at several places abroad including Caltech, Princeton University and Institute of Astronomy, Cambridge.

Professor Padmanabhan has received numerous awards and distinctions in India and abroad for his contributions. These include Young Scientist award (INSA), Shanti Swarup Bhatnagar Award (CSIR), The Millennium Medal (CSIR), G.D. Birla Award, INSA Vainu-Bappu Medal, Homi Bhabha Fellowship, J.C. Bose National Fellowship (DST), Infosys Prize for Physical Sciences (2009) and Third World Academy of Sciences Prize in Physics (2011) among others. He is an elected Fellow of all the three Academies of Science in India and the Third World Academy of Sciences. The international distinctions received by him include the position of Sackler Distinguished Astronomer from the Institute of Astronomy, Cambridge, the Al-Khwarizmi International Award and the Miegunah Fellowship of the University of Melbourne. He was the elected President of the Cosmology Commission 47 of the International Astronomical Union (2009-12) and is the Chairman of the Astrophysics Commission of the International Union of Pure and Applied Physics. His research has won prizes from the Gravity Research Foundation, USA seven times in the past including the First Prize recently in 2008.

He has authored nine books out of which seven have been published by Cambridge University Press (CUP). His book Structure Formation in the Universe [1993; CUP] has been recognized as a classic in the field and his recent three-volume treatise on Theoretical Astrophysics [2000-2002; CUP] has been widely acclaimed as an authoritative textbook. These books are used extensively in several universities and institutions all over the world as graduate level textbooks. Padmanabhan is also actively involved in the popularization of science and has authored more than a hundred articles published in Indian and international journals. His popular science book After the first three minutes [2000; CUP] has been translated into Portuguese, Chinese and Polish.

Another work of his, The story of physics, published by Vigyan Prasar, Delhi has been translated into several Indian regional languages.

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Participation

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Profile

THEO NIEUWENHUIZEN

Faculteit der Natuurwetenschappen, Universiteit van Amsterdam (UvA), NL

Theo Nieuwenhuizen concluded his master's exam cum laude in 1979, under the supervision of Professor Gerard 't Hooft, Nobel Prize Laureate and a member of the IIP's International Advisory Council. During the time studying for his PhD degree in Mathematics and Physics, he developed the thesis "Analytic methods and exact solutions for one-dimensional random systems". Nieuwenhuizen's work covers a wide variety of topics in theoretical physics, including a recently published solution to the quantum measurement problem.
He has previously worked in Brazil to organise a summer school in João Pessoa in 2012. Nieuwenhuizen now plans to visit Natal in September 2014 to start organising a school on "Quantum Foundations", to be held at the IIP in 2016.

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SPEAKER
Travis Norsen

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BOHMIAN CONDITIONAL WAVE FUNCTIONS AND THE REALITY OF THE QUANTUM STATE

Travis Norsen http://fetzer-franklin-fund.org/events/

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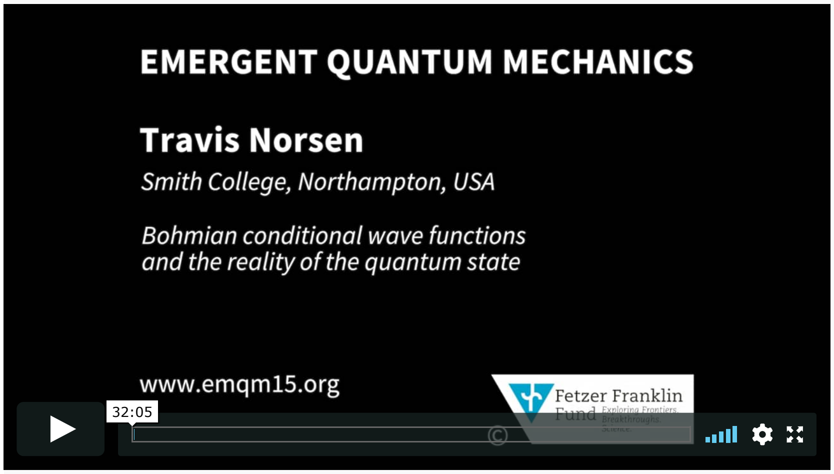

Because it allows a natural and mathematically sharp definition of “the wave function of a sub-system”, the de Broglie – Bohm pilot-wave theory provides a helpful perspective on questions about the ontological status of the quantum state. We will give a pedagogical introduction to the Bohmian conditional wave function (CWF), centered on numerical simulation of a simple toy-model system which illustrates the role of the CWF in explaining (from the pilot-wave perspective) the standard quantum formalism. We will then explain the motivation behind the program of using the Bohmian CWF to reformulate the pilot-wave theory as a “theory of exclusively local beables” (TELB).

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Profile

TRAVIS NORSEN

Smith College, Northampton, USA

Travis Norsen has taught undergraduate physics at Marlboro College, Smith College, Bridgewater State University, and Mount Holyoke College. He holds a PhD in theoretical nuclear astrophysics (University of Washington, 2002) and has made major contributions in the foundations of quantum mechanics through his work on Bell's theorem, Bohmian mechanics, and weak measurement. Travis's unique approach to teaching has been influenced by Physics Education Research, by his interests in the history and philosophy of science, by Maria Montessori, and by his own classroom experience. His goal is always to create a comfortable (and fun) learning environment in which students are encouraged -- and expected -- to make their own first-hand discoveries and to explore physics concepts deeply and thoroughly.

VIDEOS WITH TRAVIS NORSEN

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PHYSICS
Bohmian conditional wave functions and the reality of the quantum state

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WALKING ON QUANTUM FOUNDATIONS

Theo Nieuwenhuizen

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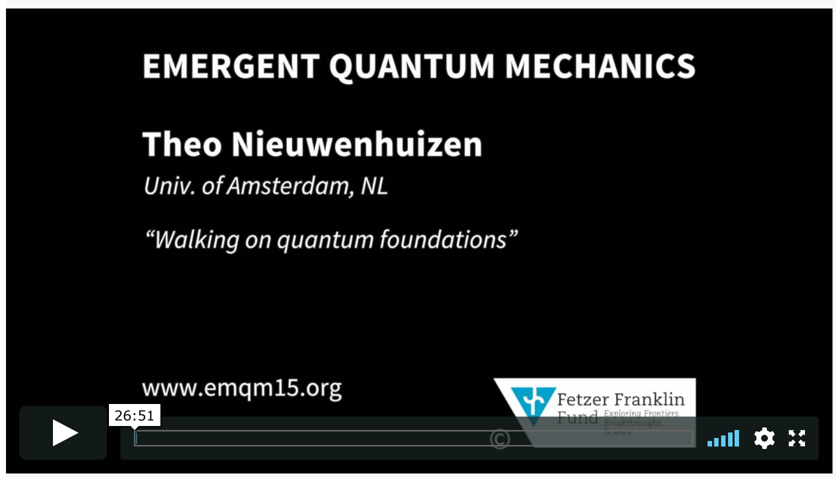

The only point of contact between the quantum formalism and reality lies in measurements. Studying quantum measurement means to model the apparatus A and solve the dynamics of when it is coupled to the tested system S. It appears that measurement goes in three steps.
First the off-diagonal elements decay by dephasing and decoherence, in a cascade of multiparticle correlations between S and A. The second step is the registration, where the pointer goes from its initial metastable state to one of the stable states. The third step, subensemble relaxation, is a new mechanism which acts near the end of the measurement inside A. Weak postulates are formulated to connect to individual measurements, thus narrowing the measurement problem. If time permits I will give details on employing lensing data of a galaxy cluster to predict a neutrino mass of 1.86 eV and their Dirac nature.

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SPEAKER
William Poirier

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QUANTUM MECHANICS WITHOUT WAVEFUNCTIONS: WHEN QUANTUM WORLDS COLLIDE

William Poirier

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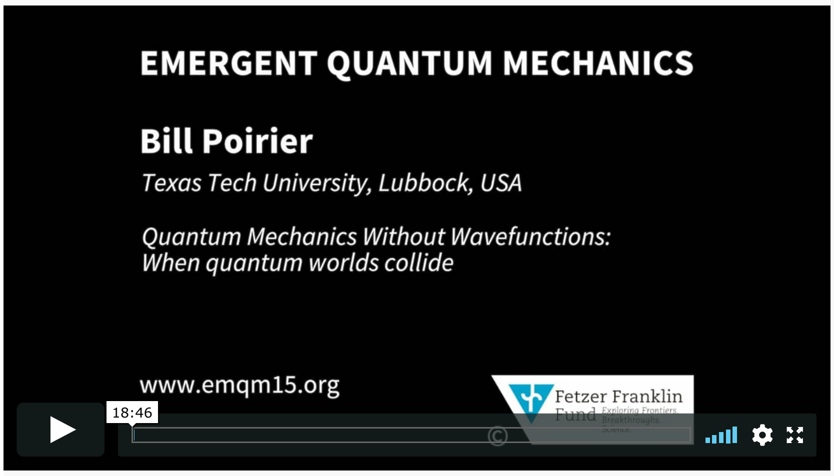

Five years ago, the first paper was published[1] that describes what has come to be known as the “Many Interacting Worlds” (MIW) interpretation of quantum mechanics (QM)[2]. MIW is based on a new mathematical formulation of QM[1,3], in which the wavefunction Ψ(t, x) is discarded. Instead, the quantum state is uniquely represented as an ensemble, x(t, C), of quantum trajectories or “worlds,” each of which has well-defined real-valued particle positions and momenta at all times. Unlike the Everett many-worlds interpretation (MWI), no world-branching occurs, and nearby trajectories/worlds influence one another dynamically. Indeed, it is through this very interworld interaction that all quantum behavior manifests. The quantum trajectory ensemble x(t, C) satisfies an action principle, leading to a dynamical partial differential equation (via the Euler-Lagrange procedure), as well as to conservation laws (via Noether’s theorem).

The MIW approach offers a direct “realist” description of nature that is beneficial in interpreting quantum phenomena such as entanglement, measurement, spontaneous decay, etc. It provides a useful analysis of the Everett Many Worlds Interpretation (MWI), explaining how the illusion of “world-branching” emerges in that context. It is also amenable to a straightforward relativistic generalization[4], which provides a notion of global simultaneity even for accelerating observers. Moreover, whereas the original MIW theory is fully consistent with Schroedinger wave mechanics, the more recently developed flavors offer the promise of new experimental predictions. These and other developments, e.g. for many dimensions, multiple particles, and spin, will be discussed.

[1] B. Poirier, Chem. Phys. 370, 4 (2010).
[2] B. Poirier, Phys. Rev. X, 4, 040002 (2014).
[3] J. Schiff and B. Poirier, J. Chem. Phys. 136, 031102 (2012).
[4] B. Poirier, arXiv:1208.6260 [quant-ph], (2012).

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Participation

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Profile

XAVIER ORIOLS

Dept.Enginyeria Electrònica Universitat Autònoma de Barcelona, ES

Education and Academic Positions

1993

Graduated in Physics from The Universitat Autonoma de Barcelona
Universitat Autonoma de Barcelona

1993

Assistant professor at the "Department d'Enginyeria Electrònica"
Universitat Autonoma de Barcelona

1994

Degree in Physics from the Universitat Autonoma de Barcelona
Universitat Autonoma de Barcelona

1997

Titular d'Escola Universitaria associate professor at the "Department d'Enginyeria Electrònica" from UAB
Universitat Autonoma de Barcelona

1998

Marie Curie fellowship from European Community; Scientific research at the CNRS-IEMN (Lille, France) with tyhe group of professor Olivier Vanbesien
Institute d'Electronique

1999

Ph.D in Electrical Enginering from Universitat Autónoma de Barcelona. (mark: Sobresaliente Cum Laude. phD Special award
Universitat Autonoma de Barcelona

2000

Advanced Master in Signal and Comuinitaction Theory from Universitat Politecnica de Catalunya
Universitat Politècnica de Catalunya

2001

Visiting professor at the Physics and Astronomy Department at SUNY (New York, USA) with the group of professor Konstantin Likahrev
New York State University at Stony brook

2003

Permanent Position as an associate professor at the "Department d'Enginyeria Electrònica"

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SPEAKER
Yakir Aharonov

PLACE
Vienna University of Technology

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TIME SYMMETRIC REFORMULATION OF QUANTUM MECHANICS

Yakir Aharonov Vienna University of Technology

I will begin my talk with a brief review of Weak Measurements and Weak Values. I will then discuss some recent developments in this field, and, in particular, the discovery that the classical limit of rare pre- and post-selected quantum systems has very novel and exciting properties. I will conclude the talk by discussing a straight forward generalization of Quantum Mechanics that solves the measurement problem and thus gets rid of the many-world interpretation of Quantum Mechanics.

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Participation

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YAKIR AHARONOV

Institute for Quantum Studies and Schmid College of Science and Technology, Chapman University & School of Physics and Astronomy, Tel Aviv University

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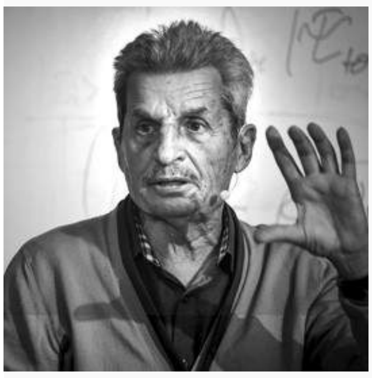

Yakir Aharonov, Ph.D., is professor of theoretical physics at Chapman University, where he holds the James J. Farley Professorship in Natural Philosophy. Considered one of the most highly regarded scientists in the world, Dr. Aharonov received the prestigious Wolf Prize in 1998 for his co-discovery of the Aharonov-Bohm Effect, one of the cornerstones of modern physics.
Born on August 28, 1932, Dr. Aharonov received his undergraduate education at the Technion, graduating with a B.Sc. in 1956. He continued his graduate studies at the Technion and then moved to Bristol University in England, together with his doctoral advisor David Bohm. He received his Ph.D. there in 1960.

Prior to coming to Chapman University in 2008, Dr. Aharonov served on the faculties of Brandeis University, Yeshiva University, Tel Aviv University, the University of South Carolina and George Mason University. He holds the title of emeritus professor from Tel Aviv University. Although Chapman University -- where he conducts research, teaches and lectures to undergraduate and graduate students in the Schmid College of Science and Technology – is his sole full-time affiliation, he also serves as distinguished professor with the Perimeter Institute in Ontario, Canada, a research think-tank where he meets and works with an international roster of renowned fellow members such as Stephen Hawking , Leonard Susskind and Juan Ignacio Cirac, among many others.

Dr. Aharonov's current research with Chapman University team members Menas Kafatos, Ph.D., Jeff Tollaksen, Ph.D. and participants from other universities includes a grant awarded from the Science and Transcendence Advanced Research Series (STAR) for a project titled "Subjective Experience as a Window on Foundational Physics." The aim of the project is to investigate the areas of tension between objective scientific description and human conscious experience.

(source: Chapman University)

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Profile

YUJI HASEGAWA

Atominstitut, TU Vienna, AT

Yuji Hasegawa is working right now at the Atominstitut der Österreichischen Universitäten, Wien. His group is engaged in quantum optical experiments with neutrons. He studied Applied Physics at the University of Tokyo, Japan and then moved in Wien between 1991 and 1992 as exchange student between TU Wien and the University of Tokyo. During his exchange in Wien, he joined the group of Prof. Rauch´s neutron interferometer at the Atominstitut.
Coming back to Tokyo, he ended his Ph.D. about interference experiments using high-energy photons, x-rays from synchrotron radiation, and neutrons.
He became a Postdoc at the University of Tokyo and constructed a precise neutron optics (PNO) beam-line at the JRR-3M, Japan Atomic Energy Research Institute (JAERI), Tokai, Japan.

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FOUNDATIONS OF QUANTUM MECHANICS STUDIED IN MATTER-WAVE OPTICS. QUANTUM CHESHIRE-CAT AND UNCERTAINTY RELATIONS

Yuji Hasegawa

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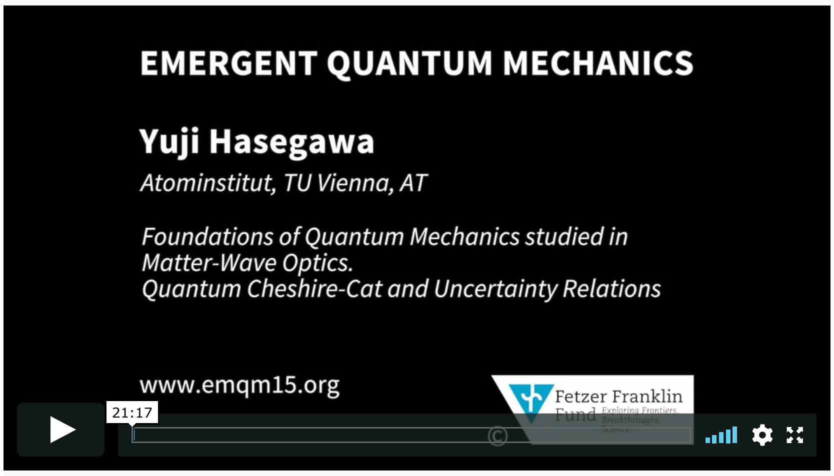

The validity of quantum-mechanical predictions has been confirmed with a high degree of accuracy in a wide range of experiments. Although the statistics of the outcomes of a measuring apparatus have been studied intensively, little has been explored and is known regarding the accessibility of quantum dynamics and the evolutions of a quantum system during measurements. For this sort of fundamental studies of quantum mechanics, interferometric and polarimetric approaches, in particular by the use of neutron's matter-waves, provide almost ideal experimental circumstances. The former device explicitly exhibits quantum interference between spatially separated beams in a macroscopic scale. In contrast, interference effects between two spin eigenstates are exposed in the latter apparatus. Exploiting both strategies, alternative theories of quantum mechanics, Kochen-Specker theorem and so on are studied. Recently, as a study of quantum dynamics, neutron interferometer experiments are carried out: a new counter-intuitive phenomenon, called quantum Cheshire-cat, is observed and full determination of weak-values of neutron's ½-spin is accomplished. In addition, extending the first experimental test of the new error-disturbance uncertainty relation by using a modified neutron polarimeter setup, we performed the experiment investigating the validity of the relation also for mixed ensemble as well as a new noise-disturbance uncertainty relation in an entropic form. In my talk, I am going to give an overview of matter-wave optical approach to investigations of fundamental aspect of quantum mechanics.

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SPEAKER
Aephraim Steinberg

FIELD OF SCIENCE
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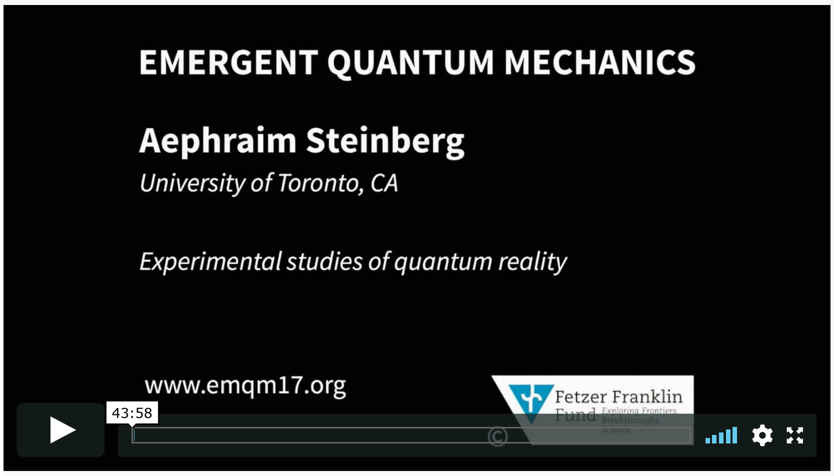
EXPERIMENTAL STUDIES OF QUANTUM REALITY

Aephraim Steinberg



I will present a number of experiments underway at Toronto using weak measurements and Bohmian mechanics to investigate what can be said about the ontology of quantum systems, specifically ones constrained by boundary conditions at both early and late times. I will begin by reviewing an experiment in which “the result of counting a single photon can be a value of 8,” and address questions about whether or not one should think of such anomalous results of weak measurements as reflecting something about reality. I will show that a realistic ontology such as Jaynes’s “neoclassical electromagnetism” would in fact lead to predictions in excellent agreement with our observations – but also that there is an experimentally accessible regime where this would break down. This is a follow-up experiment we plan to pursue in the future. I will also describe several other ongoing experiments: one which studies the essential differences between Bohm-like models which treat either position or momentum as the possible ontological variables; one in which we propose to expose the different histories experienced by particles which traverse a tunnel barrier and those which are reflected; and one where the quantum pigeonhole paradox will be used as an arena for exploring various bounds and sum rules one might expect to hold, some of which turn out to hold for strong but not for weak measurements, while others hold for weak but not for strong measurements. We believe that these experiments contribute to an evolving understanding of the elements of reality which one can ascribe to post-selected quantum systems, and to how one should attempt to view the reality underlying quantum theory more broadly.

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Profile

AEPHRAIM STEINBERG

CQIQC, University of Toronto

Aephraim Steinberg is a Professor in the Department of Physics at the University of Toronto. He is also a founding member of Toronto's Institute for Optical Sciences, a member and past director of the Centre for Quantum Information and Quantum Control (CQIQC), an affiliate member of the Perimeter Institute for Theoretical Physics and a principal investigator in Photonics Research Ontario, the Canadian Institute for Photonic Innovations, and QuantumWorks.

Dr. Steinberg received his undergraduate degree from Yale University in 1988 and his Ph.D. from the University of California at Berkeley in 1994. He then held post-doctoral fellowships at the Université de Paris VI and the U.S. National Institute of Standards and Technology before moving to Toronto in 1996. He has been a guest professor at the University of Vienna; the Institut d'Optique Théorique et Appliquée in Orsay, France; and the University of Queensland in Australia.

In 2006, he received the Canadian Association of Physicists Herzberg Medal and the Rutherford Medal in Physics from the Royal Society of Canada. In 2007, he received a Steacie Fellowship from NSERC, and a McLean Fellowship (Connaught Foundation, University of Toronto). He is a Fellow of the Institute of Physics (UK), the American Physical Society, and the Optical Society of America.

He joined CIFAR's *Quantum Information Science* Program in 2003.

Dr. Steinberg's interests lie in fundamental quantum-mechanical phenomena and the control & characterization of the quantum states of systems ranging from laser-cooled atoms to individual photons. His experimental program is two-pronged, using both nonclassical two-photon interference and laser-cooled atoms to study issues such as quantum information & computation, decoherence and the quantum-classical boundary, tunneling times, weak measurement & retrodiction in quantum mechanics, and the control and characterization of novel quantum states.

(source: University of Toronto)

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EmQM15 – Probing "surreal" elements of quantum physics using weak measurements

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EmQM13 – Experimental Information Tradeoffs: Weak Measurement, Uncertainty Relationships, et alia

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Profile

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Prof. Ana María Cetto, Research professor of the Institute of Physics and lecturer at the Faculty of Sciences, Universidad Nacional Autónoma de México. Ana María Cetto is a full-time research Professor at the Institute of Physics, and lecturer at the Faculty of Sciences, Universidad Nacional Autónoma de México (UNAM). She holds an M.A. in Biophysics from Harvard University and a M.S c and Ph.D in Physics from UNAM. Her main field of research is theoretical physics, with emphasis on the foundations of quantam mechanics, where she has contributed substantially to the development of stochastic electrodynamics. She is co-author of "The Quantum Dice" (Kluwer, 1996). Prof. Cetto is the former Dean of the Faculty of Sciences, and former head of the Theoretical Physics Department at the Institute of Physics. She chaired the project for the Museum on Light (UNAM), inaugurated in 1996. She served as consultant for the UNESCO World Conference of Science (1999). From 2003 to 2010 she served as Deputy Director General of the International Atomic Energy Agency (Nobel Peace Prize 2005), where she headed the Department of Technical Cooperation. She is founding President of LATINDEX, online information system for Ibero-American and Caribbean scholary journals. Prof Cetto has held honorary positions in a number of international organisations, such as the Executive Boards of Interciencia Association, Third World Organisation for Women in Science (TWOWS, Co-founder) and International Council for Science (ICSU), the Board of Trustees of International Foundation for Science (IFS), the Governing Board of United Nations University (UNU), the Council of International Network of Engineers and Scientists (INES) and the Executive Committee of Pugwash Conferences (Nobel Peace Prize 1995). She was appointed Mexico's Woman of the Year in 2003.

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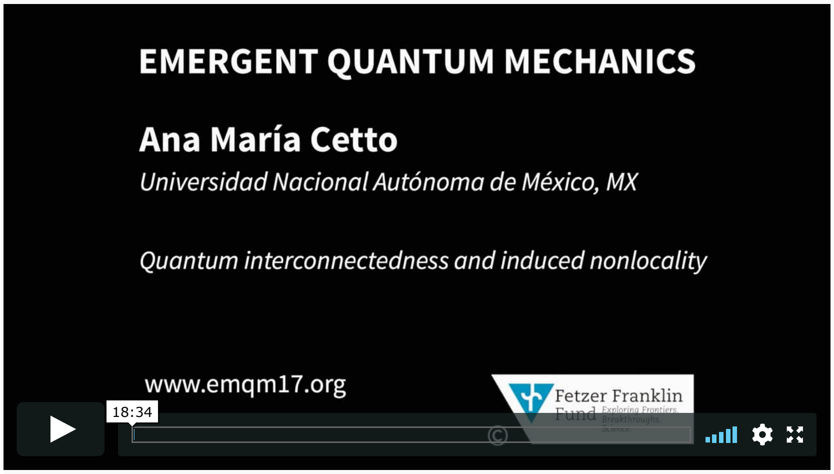
QUANTUM INTERCONNECTEDNESS AND INDUCED NONLOCALITY

Ana María Cetto



With his approach to quantum mechanics, Bohm brought back to physics two essential notions, namely causality and particle trajectories, by creatively reinterpreting the quantum formalism and postulating a novel conceptual framework that has fruitfully evolved in several directions. Quantum interconnectedness was for Bohm a fundamental principle of nature. This is the key point at which stochastic electrodynamics departs from the Bohmian approach, since in the former the cause of interconnectedness is to be found at the ontological level, and is identified with the unavoidable presence of the vacuum radiation field in permanent interaction with matter. Some central elements and results of this theory will be presented, highlighting the role of this missing element in establishing a physical link between interconnectedness and nonlocality in quantum theory.

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Profile

ANDREI KHRENNIKOV

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Andrei Khrennikov is Professor of Mathematics at the Department of Mathematics at Linnaeus University. Andrei is also director of the research group International Center for Mathematical Modeling (ICMM) and organizer of some 20 conferences in the field of quantum theory at Linnaeus University.His research activity can be characterized as extensively multi-disciplinary.

The research activities are split in the basic disciplines: Mathematics, physics, and biology, cognition, psychology and behavioral economics.

(source: Linnaeus University)

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Paper
EmQM13 – To Quantum Probabilities from Classical Random Fields and Detectors of the Threshold Type

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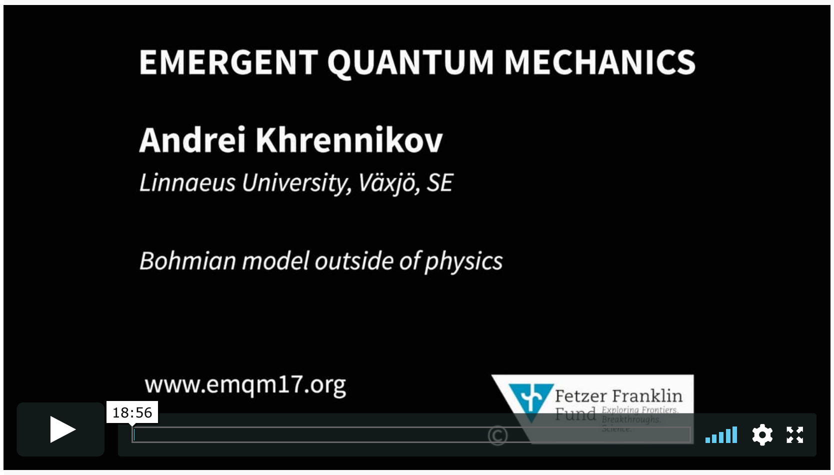
BOHMIAN MODEL OUTSIDE OF PHYSICS

Andrei Khrennikov



Following Bohm-Hiley-Pylkkänen, we apply the mathematical formalism of Bohmian mechanics to model cognition. The process of thinking is mathematically represented as classical dynamics combined with the pilot wave. The latter has the purely information meaning, the active information field. This model is nonlocal, but this is just formal. It can be created by the classical signals (e.g., electromagnetic field) in the brain at the scale which is finer then the scale of conscious processing of information. This viewpoint has the important philosophic consequence: here Bohmian mechanics is not an ontic model, but the epistemic model about the knowledge which consciousness can extract from physical world and unconsciousness. For cognition, the configuration space has the tree like structure generated by the neuronal trees in the brain. Therefore it may be useful to work with Bohmian-like models based on treelike configuration spaces. An important class of such spaces is based on the fields of p-adic numbers. Then we apply this model to finance. Here the financial market can be modeled as a nonlocal information system which parts are coupled via the quantum potential. We apply the equations of Bohmian mechanics (including stochastic generalizations) to model dynamics of the prices of shares.

References: [1] A. Khrennikov, Classical and quantum mechanics on p-adic trees of ideas. BioSystems, 56, 95-120 (2000). [2] A. Khrennikov, Information dynamics in cognitive, psychological, social, and anomalous phenomena. Ser.: Fundamental Theories of Physics, Kluwer, Dordrecht, 2004.

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Profile

ANTHONY AGUIRRE

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Anthony Aguirre is a professor of physics at the University of California, Santa Cruz, and the associate scientific director of the Foundational Questions Institute, a nonprofit organization that he co-founded and co-runs.

He received his doctorate in astronomy from Harvard University in 2000 and then spent three years as a member of the Institute for Advanced Study in Princeton before accepting a professorship in the physics department of the University of California, Santa Cruz.

He has worked on a wide variety of topics in theoretical cosmology (the study of the formation, nature, and evolution of the universe), including the early universe and inflation, gravity physics, first stars, the intergalactic medium, galaxy formation, and black holes.

(source: anthony-aguirre.com)

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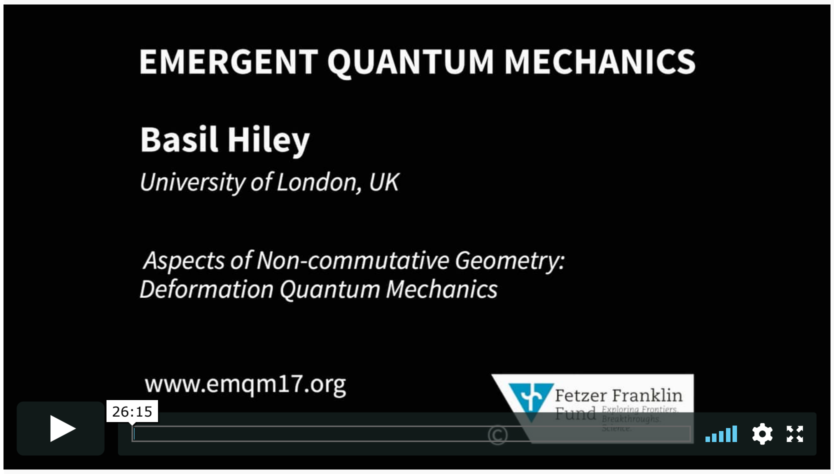
ASPECTS OF NON-COMMUTATIVE GEOMETRY: DEFORMATION QUANTUM MECHANICS

Basil J. Hiley



In a little known 1931 paper, von Neumann shows how it is possible to discuss quantum mechanics, not in terms of Hilbert space, but in terms of a non-commutative quantum phase space. This structure turns out to be identical to the algebra introduced in 1949 by Moyal in a different context. The resulting non-commutative symplectic algebra contains the classical Poisson algebra as a sub-structure resulting in deformation quantum mechanics. The importance of this algebra for the subject of this conference is that it shows exactly how the Bohm approach emerges from this non-commutative structure as a projection onto a commutative phase space. It also shows how weak values arise in this non-commutative structure. I will explain how this general structure faces similar problems to that raised in Penrose's palatial twistor theory which involves combining a symplectic structure with an orthogonal Clifford algebra in a non-trivial way.

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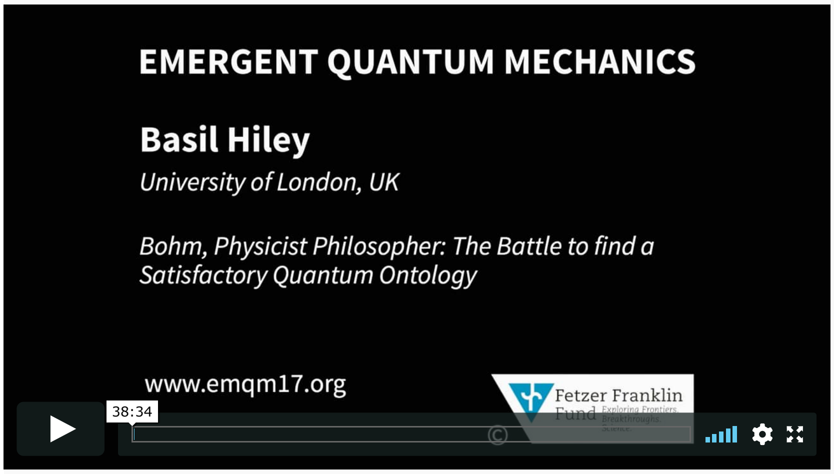
BOHM, PHYSICIST PHILOSOPHER: THE BATTLE TO FIND A SATISFACTORY QUANTUM ONTOLOGY

Basil J. Hiley



I was a colleague and collaborator of David Bohm for over thirty years at Birkbeck College. In this talk I will try to convey the spirit in which he worked as he struggled to develop a comprehensive ontology for quantum phenomena that would be rich enough to include general relativity. More ambitiously, he wanted to provide a conceptual structure that would be general enough to begin to answer some of the deep physical and philosophical questions that arise in the mind-matter relationship. In this talk I will concentrate more on the physics as this is the area in which we collaborated most. In particular I want to concentrate on his earlier 1952 papers which David saw in a very different light from the more recent discussions under the heading “Bohmian mechanics”. I want to make it clear that he totally rejected any mechanical ontology for quantum phenomena. For Bohm, ‘wholeness’ in the sense of Bohr and Whitehead, was a key, essential element of any satisfactory ontology. I will also discuss how the more recent developments in the experimental domain involving weak measurements, carried out in Toronto and being extended here in University College, London, are providing a fitting legacy to his pioneering work in this field.

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Profile

BASIL J. HILEY

Theoretical Physics Research Unit, University of London

Basil J. Hiley is a British quantum physicist and professor emeritus of the University of London. He received the Majorana Prize "Best person in physics" in 2012.

Long-time co-worker of David Bohm, Hiley is known for his work with Bohm on implicate orders and for his work on algebraic descriptions of quantum physics in terms of underlying symplectic and orthogonal Clifford algebras. Hiley co-authored the book The Undivided Universe with David Bohm, which is considered the main reference for Bohm's interpretation of quantum theory.

The work of Bohm and Hiley has been characterized as primarily addressing the question "whether we can have an adequate conception of the reality of a quantum system, be this causal or be it stochastic or be it of any other nature" and meeting the scientific challenge of providing a mathematical description of quantum systems that matches the idea of an implicate order.

Basil Hiley was born 1935 in Burma, where his father worked for the military for the British Raj. He moved to Hampshire, England, at the age of twelve, where he attended secondary school. His interest in science was stimulated by his teachers at secondary school and by books, in particular The Mysterious Universe by James Hopwood Jeans and Mr Tompkins in Wonderland by George Gamow.

Hiley performed undergraduate studies at King's College London. He published a paper in 1961 on the random walk of a macromolecule, followed by further papers on the Ising model, and on lattice constant systems defined in graph theoretical terms. In 1962 he obtained his PhD from King's College in condensed matter physics, more specifically on cooperative phenomena in ferromagnets and long chain polymer models, under the supervision of Cyril Domb and Michael Fisher.

Hiley first met David Bohm during a week-end meeting organized by the student society of King's College at Cumberland Lodge, where Bohm held a lecture. In 1961 Hiley was appointed assistant lecturer at Birkbeck College, where Bohm had taken the chair of Theoretical Physics shortly before. Hiley wanted to investigate how physics could be based on a notion of process, and he found that David Bohm held similar ideas. He reports that during the seminars he held together with Roger Penrose he was particularly fascinated by John Wheeler's "sum over three geometries" ideas that he was using to quantise gravity.

Hiley worked with David Bohm for many years on fundamental problems of theoretical physics. Initially Bohm's model of 1952 did not feature in their discussions; this changed when Hiley asked himself whether the "Einstein-Schrödinger equation", as Wheeler called it, might be found by studying the full implications of that model. They worked together closely for three decades. Together they wrote many publications, including the book The Undivided Universe: An Ontological Interpretation of Quantum Theory, published 1993, which is now considered the major reference for Bohm's interpretation of quantum theory.

In 1995, Basil Hiley was appointed to the chair in physics at Birkbeck College at the University of London. He was awarded the 2012 Majorana Prize in the category The Best Person in Physics for the algebraic approach to quantum mechanics and furthermore in recognition of "his paramount importance as natural philosopher, his critical and open minded attitude towards the role of science in contemporary culture".

(source: Wikipedia)

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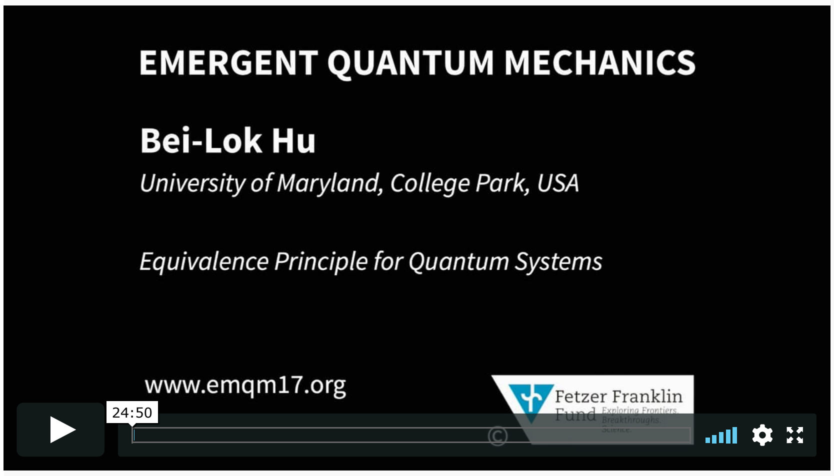
EQUIVALENCE PRINCIPLES FOR QUANTUM SYSTEMS

Bei-Lok Hu



We ask the question how the (weak) equivalence principle established in classical gravitational physics should be reformulated and interpreted for massive quantum objects that may also have internal degrees of freedom (dof). This is necessary because even an elementary concept like a classical trajectory is not well defined in quantum physics – trajectories originating from quantum histories become viable entities only under stringent decoherence conditions. For quantum composite particles freely falling in a homogeneous gravitational field we calculate the interaction between the internal dof and the translational dof and try to identify observable consequences. Concerning the effects on the translational dof, for a particular class of initial states, we show that the internal dof can lead to the dephasing, namely, the suppression of the off-diagonal terms of the density matrix, in the position basis. Contrary to a recent claim, this phenomenon is not universal and the process is not decoherence, because it does not involve irreversible loss of information. Concerning the effects on the internal dof of a free-falling atom, we found a gravitational phase shift in the reduced density matrix of the internal dof. While this phase shift is a fully quantum effect, it has a natural classical interpretation in terms of gravitational red-shift and special relativistic time-dilation. From this investigation we posit two statements of the equivalence principle for quantum systems: Version A: The probability distribution of position for a free-falling particle is the same as the probability distribution of a free particle, modulo a mass-independent shift of its mean. Version B: Any two particles with the same velocity wave-function behave identically in free fall, irrespective of their masses. Based on the recent paper by C. Anastopoulos and B. L. Hu, "Equivalence Principle for Quantum Systems: Dephasing and Phase Shift of Free-Falling Particles" arXiv:1707.04526

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Physics

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BEI-LOK HU

Maryland Center for Fundamental Physics and Joint Quantum Institute University of Maryland

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Prof Bei-Lok Hu got his PhD in theoretical physics from Princeton University in 1972 under the late Professor John A. Wheeler. After postdoctoral work at Stanford University, University of California, Berkeley and Santa Barbara in mathematics, physics and astrophysics, he was appointed an honorary research fellow at Harvard University in 1979 before he assumed his current position at the University of Maryland in 1980.

Prof Hu's research in the 70's was on quantum field theory in curved spacetime with applications to quantum processes in the early universe, for that work he was elected Fellow of the American Physical Society. Professor Hu began pioneering work on nonequilibrium quantum field theory in the 80's which resulted in a book with Dr. Calzetta by this title published in 2008 in the Cambridge Monograph in Mathematical Physics series. In 1990 Prof Hu began his seminal work on quantum decoherence and non-Markovian processes of open quantum systems. Since 2000 he has been studying quantum entanglement dynamics in atomic-optical systems with applications to quantum information processing. He is a founding fellow of the Joint Quantum Institute dedicated to the advancement of quantum science and its applications. He is also the chief architect in the inauguration of the International Society for Relativistic Quantum Information in 2010. His current research interest is on foundational issues of quantum and statistical mechanics behind macroscopic quantum phenomena and quantum thermodynamics.

Prof Hu is a world-renowned leader in quantum gravity research. His long-held critically independent viewpoint that general relativity is a hydrodynamic theory first presented at the Second Sakharov Conference in 1996 has, alongside with his Maryland colleague Jacobson's 1995 paper on viewing Einstein's equation as an equation of state, as well as work from the condensed matter community by Volovik and Wen, helped ushered in a vibrant field known today as emergent gravity.

(source: HKUST Jockey Club Institute for Advanced Study)

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Profile

BRUCE CARLSON

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Bruce M. Carlson, M.D., Ph.D. is Professor Emeritus of Anatomy and Cell Biology at the University of Michigan. After receiving an M.S. in ichthyology at Cornell University, he completed his medical and doctoral studies at the University of Minnesota. Over 40 years, he was a faculty member in the Departments of Anatomy and Cell Biology and Biology at the University of Michigan. After stepping down as Chair of Anatomy and Cell Biology, he directed the Institute of Gerontology. His research involved limb and muscle regeneration, limb embryology and the biology of aging and denervated muscle.

Along with 200 papers, he has authored 13 books on regeneration, embryology and lake biology and has edited another 15 symposium volumes and translations. He has received a number of awards, including the AAAS Newcomb-Cleveland Prize, the Henry Gray Award of the American Association of Anatomists, which he served as President, and membership in the Russian Academy of Natural Sciences. He has conducted research for extended periods in the USSR, Czechoslovakia, the Netherlands, Finland and New Zealand. His retirement activities include writing books and directing a long-term study of pike growth in an isolated northern Minnesota lake.

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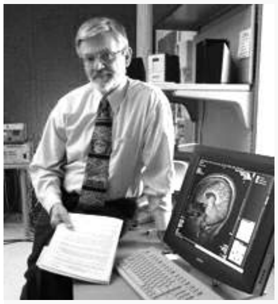

Christopher Green, M.D., Ph.D., FAAFS is Professor and Assistant Dean for China/Asia Pacific at Wayne State University School of Medicine, and at Detroit Medical Center Departments of Diagnostic Radiology and Psychiatry, and at the Chinese Academy of Sciences. Previously he was Assistant National Intelligence Officer Executive Branch, US Government, and later Chief Technology Officer Asia-Pacific General Motors. He also lived in Washington D.C., China and Singapore.

Kit founded and serves on the boards of several international neurotechnology and genomic companies. He uses high-field MRI for patients with complex forensic neurological disorders. He pursued his Ph.D. and M.D. degrees at Wisconsin, Colorado, and Ciudad Juarez University Schools of Medicine and is medically licensed in many states and WHO countries. As Holder of the National Intelligence Medal, and Lifetime Member of the National Research Council and the National Academy of Sciences, Kit has served and chaired numerous Department of Defense Science Boards and has authored over 20 academic monographs and studies in neurology, and biophysics. His passion is in brain imaging, neurotoxicology and genomics, and cognition. He is a Fellow in the American Academy of Forensic Sciences.

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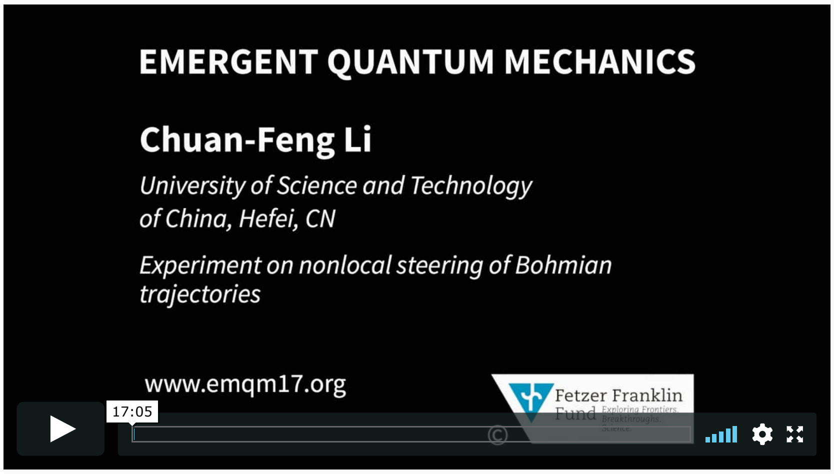
EXPERIMENT ON NONLOCAL STEERING OF BOHMIAN TRAJECTORIES

Chuan-Feng Li



Interpretations of quantum mechanics (QM), or proposals for underlying theories, that attempt to present a definite realist picture, such as Bohmian mechanics, require strong non-local effects. Naively, these effects would violate causality and contradict special relativity. However if the theory agrees with QM the violation cannot be observed directly. We demonstrate experimentally such an effect: we steer the velocity and trajectory of a Bohmian particle using a remote measurement. We use a pair of photons and entangle the spatial transverse position of one with the polarization of the other. The first photon is sent to a double-slit-like apparatus, where its trajectory is measured using the technique of Weak Measurements. The other photon is projected to a linear polarization state. The choice of polarization state, and the result, steer the first photon in the most intuitive sense of the word. The effect is indeed shown to be dramatic, while being easy to visualize. We discuss its strength and what are the conditions for it to occur.

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Profile

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Download vita

Professor Chuan-Feng Li is born in Feb. 1973 in Shandong Province. He gets to University of Science and Technology of China (USTC) in 1990 as an undergraduate, then gets his doctorate in 1999 in the department of physics of USTC, supervised by Prof. Guang-Can Guo.

Now, he is a professor of department of optics & optical engineering and Key Lab of Quantum Information of USTC. Prof. Li's research area is quantum optics and quantum information. Now, he is concentrating on constructing a featured quantum entanglement network and exploring quantum physics with developed quantum information technology.

(source: University of Science and Technology of China)

VIDEOS WITH CHUAN-FENG LI

VIDEO

PHYSICS

Experiment on nonlocal steering of Bohmian trajectories

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SPEAKER
Emily Adlam

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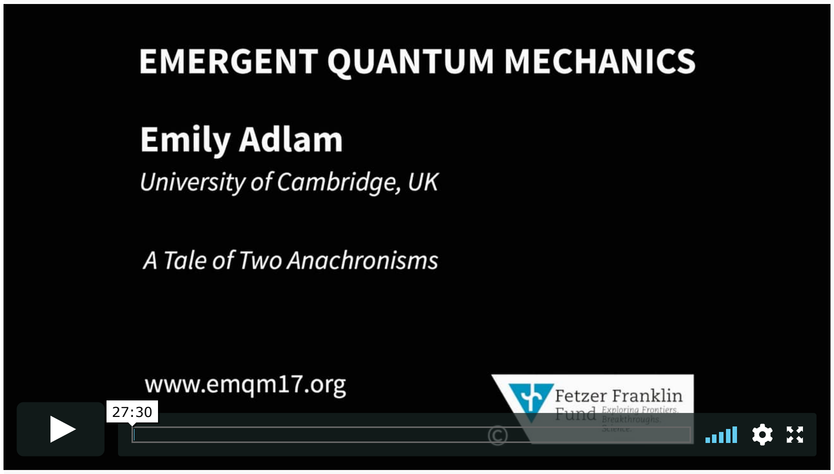
A TALE OF TWO ANACHRONISMS

Emily Adlam



Scientific reasoning is constrained not only by the outcomes of experiments, but also by the history of human thought and our own place in it. As a result, even our best theoretical models often incorporate features which are present more as the result of historical accident than as the endpoint of a process of evidence-based deliberation, and it is sometimes possible to make considerable progress by identifying and eliminating such features. In this talk, I will identify two features of current thought about quantum physics which may be anachronisms of this kind, then briefly discuss their history and raise some arguments against them. Both of these features have previously been recognised as problematic by parts of the physics community, but I argue that this recognition is not sufficiently widespread and that both features are actively limiting progress in the field of quantum foundations.

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EMILY ADLAM

Centre for Mathematical Sciences, University of Cambridge

Emily is a PhD student in the Department of Applied Mathematics and Theoretical Physics at Cambridge, currently working on relativistic quantum cryptography. She studied physics and philosophy at Oxford, writing her Masters' thesis on the problem of confirmation in the Everett interpretation, and obtained her second Masters' degree from the Perimeter Scholars International theoretical physics programme.

She also has an MPhysPhil from the University of Oxford and an MSci from the University of Waterloo. This is Emily's first year with CamPrep and she will be teaching Artificial Intelligence.

(source: Oxbridge Academic Programs)

VIDEOS WITH EMILY ADLAM

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PHYSICS
A Tale of Two Anachronisms

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EMQM15 – EMERGENT QUANTUM MECHANICS

23/10 – 25/10/2015, Vienna University of Technology

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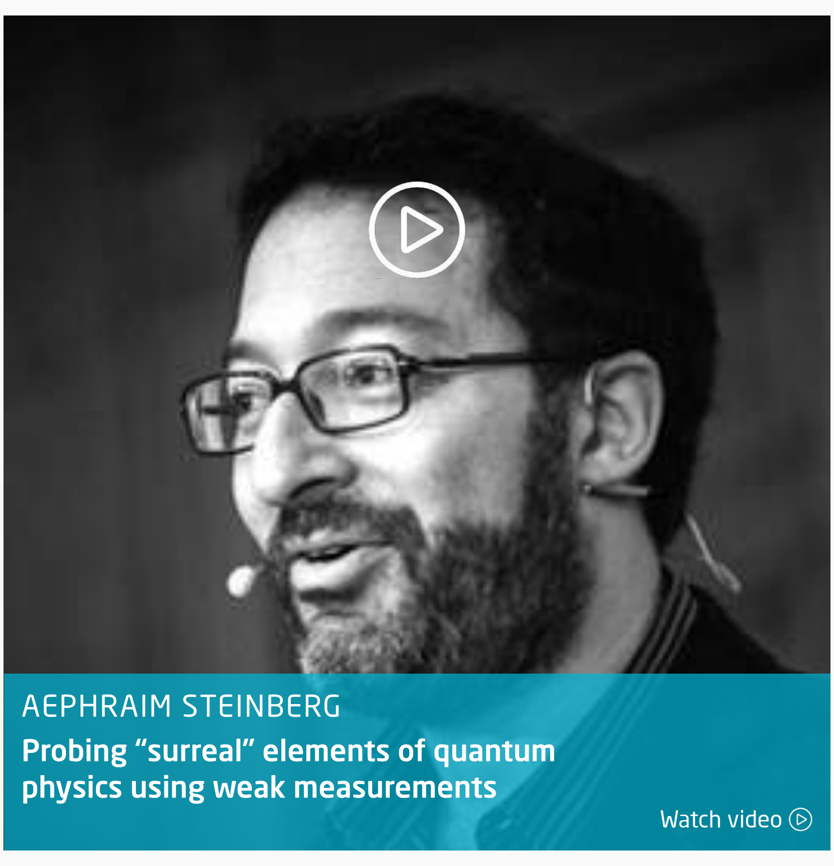
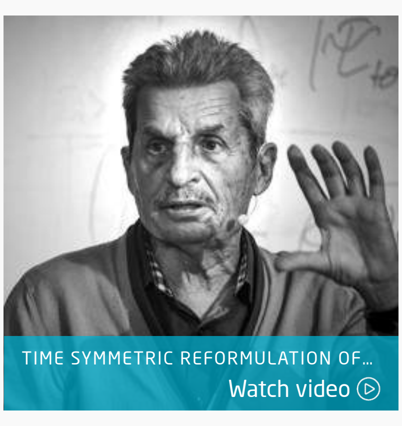
The symposium "EmQM15 - Emergent Quantum Mechanics" invites the open exploration of the quantum state as a reality. The resurgence of interest in ontological quantum theory, including both deterministic and indeterministic approaches, challenges long held assumptions and directs focus towards the following questions:

- Is the world local or nonlocal? What is the nature of quantum nonlocality?
- If nonlocal, i.e., superluminal, influences exist then why can't they be used for superluminal signalling and communication?
- How is the role of the scientific observer/agent to be accounted for in realistic approaches to quantum theory?
- How could recent developments in the field of space-time as an emergent phenomenon advance new insight at this research frontier?
- What new experiments might contribute to new understanding?

These and related questions will be addressed in the context also of a possible "deeper level theory" for quantum mechanics that interconnects three fields of knowledge: emergence, the quantum, and information. Could there appear a revised image of physical reality from recognizing new links between emergence, the quantum, and information? The symposium provides a forum for considering (i) current theoretical and conceptual obstacles which need to be overcome as well as (ii) promising developments and research opportunities on the way towards realistic quantum mechanics. Contributions are invited that present current advances in both standard as well as unconventional approaches.

VIDEOS





- **YAKIR AHARONOV:** *Time Symmetric Reformulation of Quantum Mechanics*
- **MARKUS ARNDT:** *Quantum optics with nanobiological matter*
- **PETER BARKER:** *Weak measurements of atomic momentum in a matter-wave interferometer*
- **ANGELO BASSI:** *Models of spontaneous wave function collapse: what they are, and how they can be tested*
- **HERMAN BATELAAN:** *Double slit electron diffraction*
- **KONSTANTIN BLIOKH:** *Field-Theory Revolution for Optics: Revisiting Momentum and Angular Momentum of Light*
- **ČASLAV BRUKNER:** *Quantum Clocks and Time*
- **ARIEL CATICHA:** *Trading drift and fluctuations in entropic dynamics: a new symmetry for quantum mechanics*
- **ERIC CAVALCANTI:** *The Two Bell's Theorems of John Bell and Causal Emergence*
- **ANA MARÍA CETTO:** *Two-electron system correlated by the zero-point field: physical explanation for the spin-statistics connection*
- **LAJOS DIÓSI:** *Nonlinear Schrödinger Equation in Foundations: Summary of 4 Catches*
- **HANS-THOMAS ELZE:** *Quantum Features of Natural Cellular Automata*
- **ROBERT FLACK:** *Measuring the weak value of atomic spin*
- **NICOLAS GISIN:** *Quantum correlations in Newtonian space and time: arbitrarily fast communication or nonlocality*
- **MAURICE DE GOSSON:** *Weak values and the reconstruction problem in Born-Jordan quantization*
- **GERHARD GRÖSSING:** *Conditions for Lorentz-invariant superluminal information transfer without signaling*
- **YUJI HASEGAWA:** *Foundations of Quantum Mechanics studied in Matter-Wave Optics. Quantum Cheshire-Cat and Uncertainty Relations*
- **BASIL J. HILEY:** *Weak Values, Local Momentum and Tangent Groupoids*
- **GERARD 'T HOOFT:** *How quantization of gravity leads to a discrete space-time*
- **BEI-LOK HU:** *Gravitational Cat State*
- **MARIAN KUPCZYNSKI:** *EPR Paradox, Quantum Nonlocality and Physical Reality*
- **MATT LEIFER:** *The reality of the quantum state from Kochen-Specker contextuality*
- **THEO NIEUWENHUIZEN:** *Walking on quantum foundations*
- **HRVOJE NIKOLIC:** *How to reconcile non-local reality and local non-reality*
- **TRAVIS NORSEN:** *Bohmian conditional wave functions and the reality of the quantum state*
- **XAVIER ORIOLS:** *Can Decoherence make quantum theories unfalsifiable? Understanding the quantum-to-classical transition without it*
- **THANU PADMANABHAN:** *Atoms of Spacetime and the Nature of Gravity*
- **WILLIAM POIRIER:** *Quantum Mechanics Without Wavefunctions: When quantum worlds collide*
- **HANS DE RAEDT:** *The unreasonable effectiveness of quantum theory: a logical inference approach*
- **HELMUT RAUCH:** *Ignorance governs quantum experiments*
- **MARTIN RINGBAUER:** *Measurements on the Reality of the Wavefunction*
- **AEPHRAIM STEINBERG:** *Probing "surreal" elements of quantum physics using weak measurements*
- **JEFF TOLLAKSEN:** *The Quantum pigeonhole principle and localizing Kochen-Specker contextuality with weak measurements*
- **LEV VAIDMAN:** *Ontology of the wave function*
- **JAN WALLECZEK:** *Free Will Theorems in Nonlocal Information Transfer without Nonlocal Communication*
- **JAN WALLECZEK:** *Is the World Local or Nonlocal? - Towards an Emergent Quantum Mechanics 80 Years after EPR*
- **GREGOR WEIHS:** *Multipath Interference Tests of Quantum Mechanics*
- **SILKE WEINFURTNER:** *Hydrodynamic simulations of rotating and non-rotating black holes*
- **HOWARD WISEMAN:** *Ensembles of Bohmian trajectories: Real, Surreal, and Hyper-real*

PUBLICATIONS

Book-Publication

EmQM15: Emergent Quantum Mechanics 2015
A special issue of "IOP Publishing"

These proceedings comprise the invited lectures of the third international symposium on Emergent Quantum Mechanics (EmQM15), which was held at the Vienna University of Technology in Vienna, Austria, 23-25 October 2015.

For the articles please click here.

SPEAKERS

Yakir Aharonov	Nicolas Gisin	Xavier Oriols
Markus Arndt	Maurice de Gosson	Thanu Padmanabhan
Peter Barker	Christopher Green	Hans de Raedt
Angelo Bassi	Gerhard Grössing	Helmut Rauch
Herman Batelaan	Yuji Hasegawa	Martin Ringbauer
Konstantin Bliokh	Basil J. Hiley	Aephraim Steinberg
Časlav Brukner	Gerard 't Hooft	Jeff Tollaksen
Bruce Carlson	Bei-Lok Hu	Lev Vaidman
Ariel Caticha	Marian Kupczynski	Jan Walleczek
Eric Cavalcanti	Matt Leifer	Gregor Weihs
Ana María Cetto	Theo Nieuwenhuizen	Silke Weinfurtner
Lajos Diósi	Hrvoje Nikolic	Howard Wiseman
Hans-Thomas Elze	Travis Norsen	

EVENT INFO

Website: www.emqm15.org

Location: Vienna University of Technology

Date: 23/10 – 25/10/2015

Organizers:

Jan Walleczek
Fetzer Franklin Fund, USA, and Phenoscience Laboratories, Berlin, Germany

Gerhard Grössing
Austrian Institute for Nonlinear Studies, Vienna, Austria

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EmQM13 – 3th International Symposium about Quantum Mechanics

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EMQM17 – TOWARDS ONTOLOGY OF QUANTUM MECHANICS AND THE CONSCIOUS AGENT

26/10 – 28/10/2017, University of London, Senate House, Beveridge Hall

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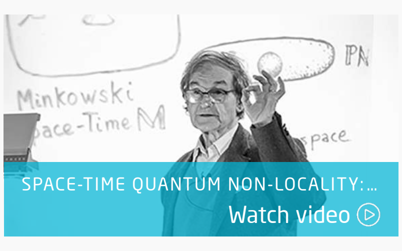
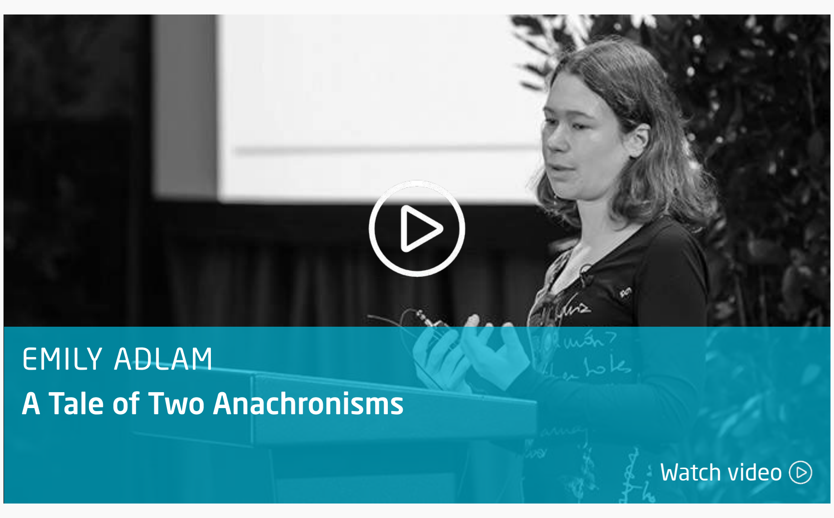
On the occasion of David Bohm's 100th birthday, the EmQM17 Symposium offered an open forum for critically evaluating the prospects and significance - for 21st century physics - of ontological quantum mechanics, an approach which David Bohm helped pioneer. Contributions were invited that presented current advances in both standard as well as realist approaches to quantum mechanics, including new experiments, work in quantum foundations, and quantum philosophy.

VIDEOS





- **EMILY ADLAM:** *A Tale of Two Anachronisms*
- **YAKIR AHARONOV:** *Finally making sense of the double-slit experiment*
- **NATHAN ARGAMAN:** *A Lenient Causal Arrow of Time?*
- **MARKUS ARNDT:** *What quantum-interference assisted molecule metrology can tell us about reality and non-locality*
- **PETER BARKER:** *Weak Measurements of Atomic Momentum*
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- **HANS-THOMAS ELZE:** *On the question of ontological states in simple (pre-)quantum models*
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- **STUART HAMEROFF:** *Anesthesia, Consciousness, Bohm and Penrose*
- **BASIL J. HILEY:** *Bohm, Physicist Philosopher: The Battle to find a Satisfactory Quantum Ontology*
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- **ANDREI KHRENNIKOV:** *Bohmian model outside of physics*
- **MATT LEIFER:** *The Problem of Fine-Tuning in Quantum Theory*
- **CHUAN-FENG LI:** *Experiment on nonlocal steering of Bohmian trajectories*
- **TIM MAUDLIN:** *Ontological Clarity, Electromagnetism and the Aharanov-Bohm Effect*
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- **HUW PRICE:** *Two Paths to the Parisian Zigzag*
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- **WARD STRUYVE:** *Must space-time be singular?*
- **MAX TEGMARK:** *Why quantum observers find lower entropy after observation and in our early universe?*
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- **RODERICH TUMULKA:** *Bohmian Trajectories as the Foundation of Quantum Mechanics and Quantum Field Theory*
- **LEV VAIDMAN:** *Are expectation values and weak values properties of single quantum systems?*
- **JAN WALLECZEK:** *Towards Ontology of Quantum Mechanics and the Conscious Agent*
- **JAN WALLECZEK:** *Nonlocality or Local Retrocausality? - The Non-signalling Theorem in Ontological Quantum Mechanics*
- **KEN WHARTON:** *Live Options for Spacetime-Based Physics*
- **HOWARD WISEMAN:** *Relativistic Causality and Bell's Theorems*

PUBLICATIONS

Book-Publication

entropy
an Open Access Journal by MDPI

"Emergent Quantum Mechanics - David Bohm Centennial Perspectives"
A special issue of "Entropy"

An **open-access special issue** of Entropy titled *"Emergent Quantum Mechanics - David Bohm Centennial Perspectives"* invited original speaker contribution: This Special Issue explores the possibility of an ontology for quantum mechanics. The focus is the search for a „deeperlevel" theory for quantum mechanics that interconnects three fields of knowledge: emergence, the quantum, and information. Contributions will be featured that present current advances in realist approaches to quantum mechanics, including new experiments, work in quantum foundations, and the physics of the quantum observer and the conscious experimenter agent.

For the **26 research articles** for the **Entropy special issue** please click here.

SPEAKERS

Emily Adlam	Maurice de Gosson	Jonathan Schooler
Anthony Aguirre	Christopher Green	William Seager
Yakir Aharonov	Gerhard Grössing	Aephraim Steinberg
Nathan Argaman	Stuart Hameroff	Nikolaus von Stillfried
Markus Arndt	Basil J. Hiley	Ward Struyve
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Herman Batelaan	Andrei Khrennikov	Jeff Tollaksen
Bruce Carlson	Matt Leifer	Roderich Tumulka
Ana María Cetto	Chuan-Feng Li	Lev Vaidman
Hans-Thomas Elze	Tim Maudlin	Jan Walleczek
Thomas Filk	Tim Palmer	Ken Wharton
Robert Flack	Sir Roger Penrose	Howard Wiseman
Shan Gao	Huw Price	
Nicolas Gisin	Paavo Pylkkänen	

EVENT INFO

Website: http://emqm17.org

Location: University of London, Senate House, Beveridge Hall

Date: 26/10 - 28/10/2017

Organizers:

Jan Walleczek
Fetzer Franklin Fund, USA, and Phenoscience Laboratories, Berlin, Germany

Gerhard Grössing
Austrian Institute for Nonlinear Studies, Vienna, Austria

Paavo Pylkkänen
University of Helsinki, Finland, and University of Skövde, Sweden

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Tim Maudlin

FIELD OF SCIENCE
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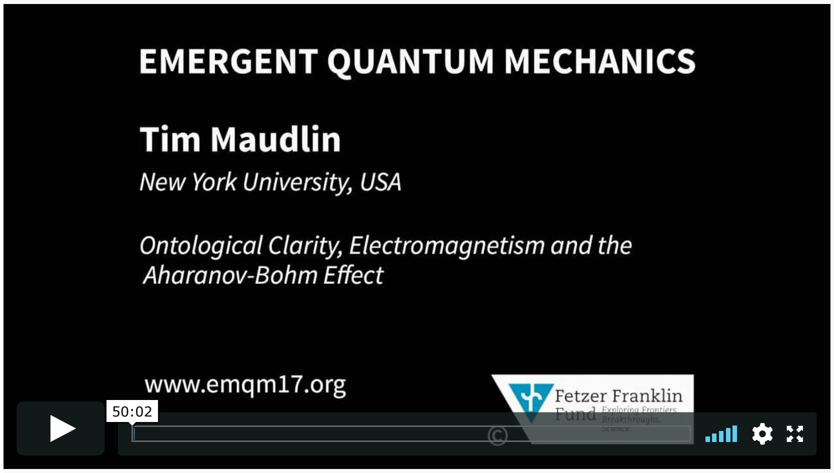
ONTOLOGICAL CLARITY, ELECTROMAGNETISM AND THE AHARANOV-BOHM EFFECT

Tim Maudlin



Mathematical physics uses abstract mathematical structures to represent physical states of the world. But the physical world is not literally made of those mathematical structures, so there must be some account of how the mathematics is to be understood. This requires a clear statement of the physical ontology postulated by a theory and a commentary on how the mathematical degrees of freedom correspond (or fail to correspond) to the physical degrees of freedom. Classical electro-magnetic theory provides a wonderful illustration of this point. I will offer a disciplined way to present the ontological and nomological commitments of a theory, and show how many different physical theories can be associated with one and the same mathematical formalism. I will then discuss the bearing of the Aharonov-Bohm effect on the choice among this multiplicity.

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SPEAKER
Gerhard Grössing

FIELD OF SCIENCE
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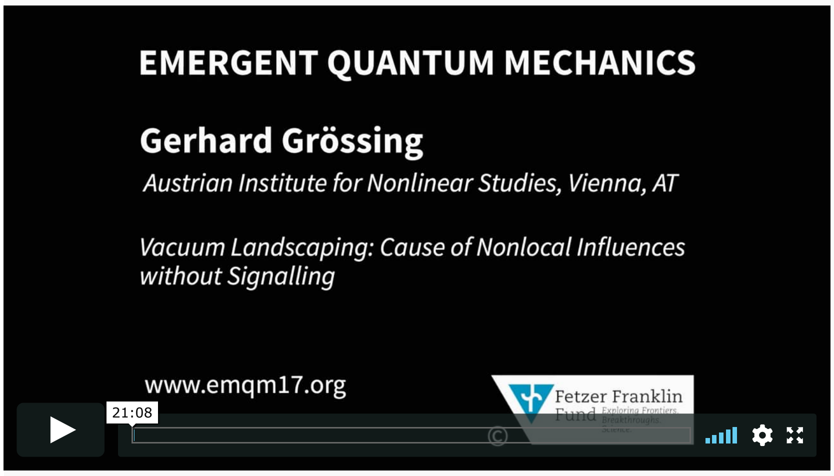
VACUUM LANDSCAPING: CAUSE OF NONLOCAL INFLUENCES WITHOUT SIGNALLING

Gerhard Grössing



In the quest for an understanding of nonlocality with respect to an appropriate ontology, we propose a "cosmological" solution. We assume that from the beginning of the Universe each point in space has been the location of a scalar field representing a zero-point vacuum energy that vibrates at a vast range of different frequencies across the whole Universe. A quantum, then, is a nonequilibrium steady state in the form of a "bouncer" coupled resonantly to one of those (particle type dependent) frequencies, in remote analogy to the bouncing oil drops on an oscillating oil bath as in Couder's experiments. A major difference to the latter analogy is given by the nonlocal nature of the vacuum oscillations. With these assumptions, we can replicate quantum mechanical features exactly by subjecting classical particle trajectories to diffusive processes caused by the presence of the zero point field, with the important property that the probability densities involved extend, however feebly, over the whole setup of an experiment. The model employs a two-momentum approach to the particle propagation, i.e., forward and osmotic momenta. The form of the latter has been derived without any recurrence to other approaches such as Nelson's.
We show with the examples of double and n-slit interference that the assumed nonlocality of the distribution functions alone suffices to derive the de Broglie-Bohm guiding equation with otherwise purely classical means. In our model, no influences from configuration space are required, as everything can be described in 3-space. Importantly, the setting up of an experimental arrangement limits and shapes the osmotic contributions and is described as vacuum landscaping. Accordingly, any change of the boundary conditions can be the cause of nonlocal influences throughout the whole setup, thus explaining, e.g., Aspect-type experiments. We argue that these influences can in no way be used for signalling purposes in the communication theoretic sense, and are therefore fully compatible with special relativity.

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Profile

GERHARD GRÖSSING

Austrian Institute for Nonlinear Studies

Dr. Gerhard Grössing is Co-Founder and Director of the Austrian Institute for Nonlinear Studies (AINS) in Vienna, Austria. He studied physics and mathematics at the University of Vienna and at Iowa State University, USA. During his post-doctoral work at Vienna's Atominstitut, he coined the term and developed, together with Anton Zeilinger, the first "Quantum Cellular Automata", and he developed an early variant of an "emergent" quantum theory named "Quantum Cybernetics" whose main results were published as a monograph with Springer Verlag, New York.

His major research interests cover the foundations of quantum theory and new tools in complex systems research. Apart from his scientific work per se, he has a continued interest in the fields of philosophy and foundations of science, where he also published numerous articles and two books. In recent years, the research of Gerhard Grössing and the AINS has focused on the development of an "Emergent Quantum Mechanics". He has organized at the University of Vienna the first international conference exclusively devoted to this promising and rapidly developing field, whose contributions are collected in a volume published by the Institute of Physics

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William Seager

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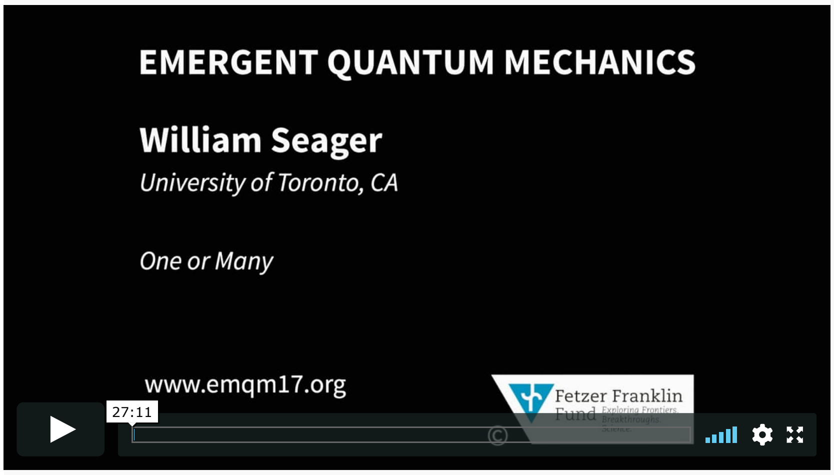
William Seager



The question of whether reality should be conceived of as a single holistic unity or as a plurality of fundamental and independently existing entities is a truly ancient one. This metaphysical question may seem to be a purely philosophical issue on which empirical science can have little to contribute. And yet, as in the case of the Bell Inequality, Quantum Mechanics appears to open a door leading to something like Abner Shimony's 'experimental metaphysics'. In this regard, the views of David Bohm are especially interesting. Bohm had deep philosophical interests, which included highly interesting ideas about mind and consciousness, but his interpretation of Quantum Mechanics may seem somewhat 'schizophrenic' when it faces the one versus many question. Bohm is famous for developing an interpretation which allowed genuine particles (i.e. definite in position and momentum; definite trajectories) in its ontology. But the interpretation also includes 'guidance' by the universe spanning wave function which co-ordinates the motion of the particles. And Bohm once wrote that 'entire universe must, on a very accurate level, be regarded as a single indivisible unit in which separate parts appear as idealizations permissible only on a classical level of accuracy of description'. But what does this last remark mean? Idealization is, prima facie, an activity of the mind. Are 'classical objects' then mind dependent, transforming idealization into idealism? What is the 'indivisible unit'? I examine here whether the philosophical theory called 'neutral monism' can motivate a picture in which Bohm's philosophical aims, including his approach to the mind-body problem, can capture both the urge towards monism and that towards pluralism.

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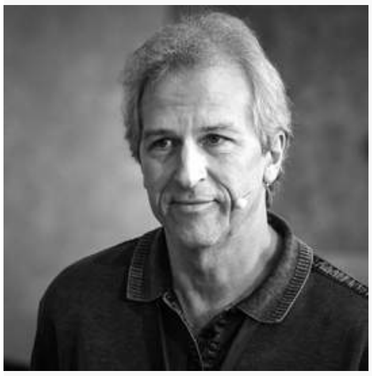
HANS-THOMAS ELZE

Dipartimento di Fisica "Enrico Fermi", Università di Pisa



Hans-Thomas Elze is a theoretical physicist. - Phd at University of Frankfurt (1985), followed by positions in Berkeley, Helsinki, and 3 years spent at CERN. Professorships in Bremen, Regensburg, and Tucson (Arizona). Professor at Brazil's renowned Universidade Federal do Rio de Janeiro (1997-2004).

Affiliated with Universita di Pisa (since 2004). - Several Fellowships, notably Heisenberg Fellow Award (German science foundation, DFG) for quantum transport theory in gauge theories. Organizer of biannual DICE (foundations of physics) conferences in Italy since 2002.

Present interests include: entanglement entropy, decoherence, emergence of quantum mechanics.

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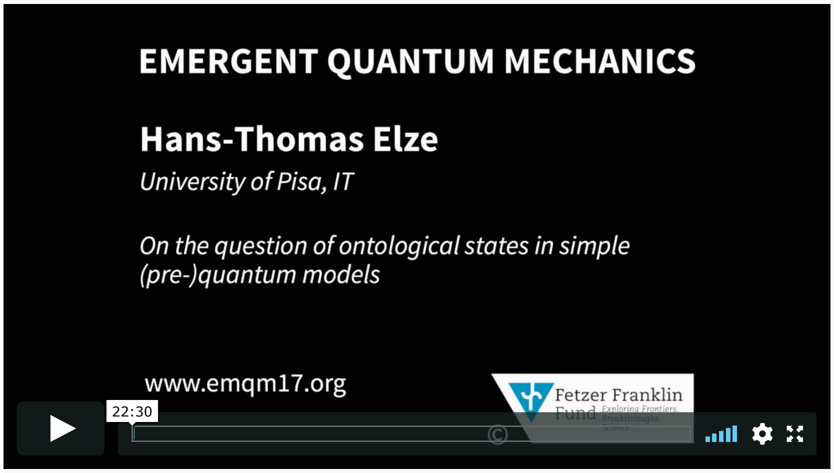
ON THE QUESTION OF ONTOLOGICAL STATES IN SIMPLE (PRE-)QUANTUM MODELS

Hans-Thomas Elze



The quantum-mechanical features of Hamiltonian cellular automata (CA) are described, i.e., of CA with integer-valued variables and couplings that follow linear updating rules. We then discuss whether, in this class of CA, there is room for systems that evolve by permutations of a set of ontological states, thus providing examples for G. 't Hooft's recent CA Interpretation of Quantum Mechanics. Multi-partite systems consisting of interacting two-state components are promising in this respect and may lead to physically interesting models.

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Profile

HERMAN BATELAAN

Department of Physics and Astronomy, University of Nebraska

Herman Batelaan studies the fundamental interaction between light, electrons and atoms.

His interests focus on studying the foundations of quantum mechanics and electromagnetic interactions.

These studies include theoretical analysis, simulation using supercomputing (HCC and XSEDE), and a strong emphasis on experiment.

(source: Department of Physics & Astronomy)

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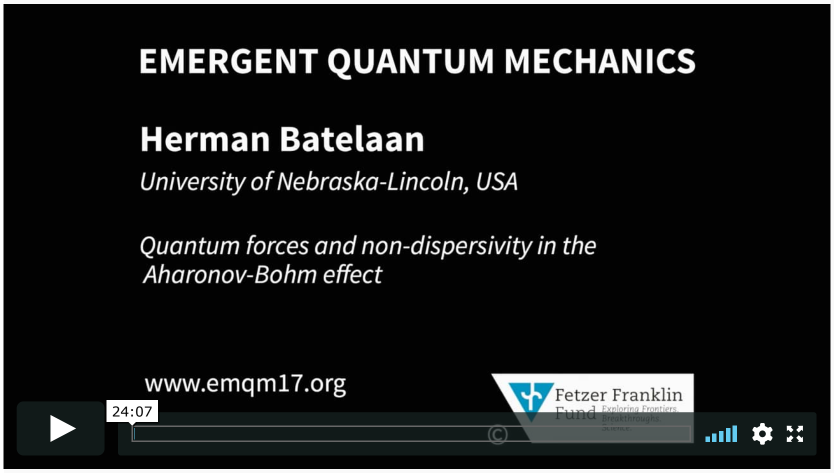
QUANTUM FORCES AND NON-DISPERSIVITY IN THE AHARONOV-BOHM EFFECT

Herman Batelaan



Decades ago, it was shown that electrons can be affected by electromagnetic potentials without experiencing force-fields with the advent of the Aharonov-Bohm effect. Zeilinger’s theorem related the absence of classical force fields in quantum terms as the “dispersionless” nature of the Aharonov-Bohm effect. In contrast, in the late 1990’s a quantum force was predicted for the Aharonov-Bohm physical system by Shelankov, and elucidated by Berry. Here we show experimentally that this force is indeed present. We show theoretically that Zeilinger’s theorem on the dispersionless nature is not generally applicable to the Aharonov-Bohm system.

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SPEAKER
Howard Wiseman

FIELD OF SCIENCE
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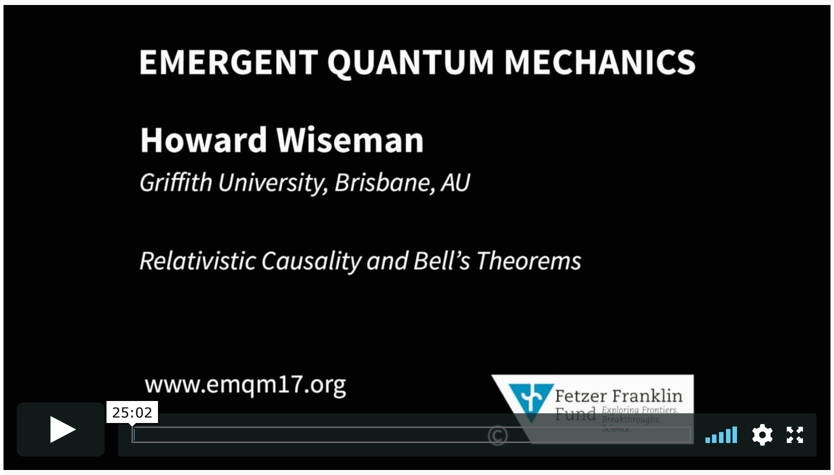
RELATIVISTIC CAUSALITY AND BELL'S THEOREMS

Howard Wiseman



"Bell's theorem" can refer to two different things. One is the theorem that John Bell proved in 1964; the other, the theorem he proved in 1976. His 1964 theorem is the incompatibility of quantum phenomena with the joint assumptions of LOCALITY and PRE-DETERMINATION. His 1976 theorem is their incompatibility with the single property of LOCAL CAUSALITY. Although the two Bell's theorems are logically equivalent, their assumptions are not. Hence, the earlier and later theorems suggest quite different conclusions, embraced by operationalists and realists, respectively. The key issue is whether LOCALITY or LOCAL CAUSALITY is an appropriate expression of RELATIVISTIC CAUSALITY. The answer rests on one's basic notion of causation. For operationalists the appropriate notion is what I will call the Principle of AGENT-CAUSATION, while for realists it is REICHENBACH's Principle. However, by breaking down the latter into even more basic Postulates – COMMON CAUSE and DECORRELATION – it is possible to obtain a version of Bell's theorem in which each camp could reject one assumption and be satisfied that those remaining reflect its Weltanschauung. Formulating Bell's theorem in terms of causation is fruitful not just for attempting to reconcile the two camps, but also for better describing the ontology of different quantum interpretations and for more deeply understanding the implications of quantum mechanics. Time permitting, I will discuss what the implications might be for our notions of causality and/or the most satisfactory interpretations, as I see it.

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Huw Price is Bertrand Russell Professor of Philosophy and a Fellow of Trinity College at the University of Cambridge. He is Academic Director of the Leverhulme Centre for the Future of Intelligence, and was founding Academic Director of the Centre for the Study of Existential Risk, which he established in 2012 with Martin Rees and Jaan Tallinn. Before moving to Cambridge he was ARC Federation Fellow and Challis Professor of Philosophy at the University of Sydney, where from 2002–2012 he was Director of the Centre for Time. His publications include Facts and the Function of Truth (Blackwell, 1988; 2nd. edn. OUP, forthcoming), Time's Arrow and Archimedes' Point (OUP, 1996), Naturalism Without Mirrors (OUP, 2011) and a range of articles in journals such as Nature, Science, Philosophical Review, Journal of Philosophy, Mind, and British Journal for the Philosophy of Science. He is also co-editor (with Richard Corry) of Causation, Physics, and the Constitution of Reality: Russell's Republic Revisited (OUP, 2007). His René Descartes Lectures (Tilburg, 2008) were published as Expressivism, Pragmatism and Representationalism (CUP, 2013), with commentary essays by Simon Blackburn, Robert Brandom, Paul Horwich and Michael Williams.

He is a Fellow of the British Academy, a Fellow and former Member of Council of the Australian Academy of the Humanities, and a Past President of the Australasian Association of Philosophy. He was consulting editor for the Stanford Encyclopedia of Philosophy from 1995-2006, and is an associate editor of The Australasian Journal of Philosophy and a member of the editorial boards of Contemporary Pragmatism, Logic and Philosophy of Science, the Routledge International Library of Philosophy, and the European Journal for Philosophy of Science.

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TWO PATHS TO THE PARISIAN ZIGZAG

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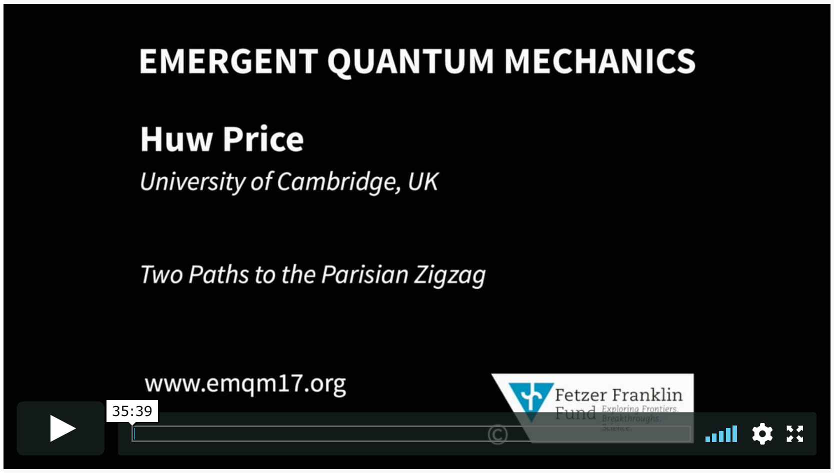

In 1953 O. Costa de Beauregard, a student of de Broglie, raised an objection to the EPR argument. Einstein, Podolsky and Rosen had assumed that there is no action at a distance; "that would be magic", as Schrödinger said at the time. Costa de Beauregard pointed out that the quantum world might allow spacelike causal influence, without such magic, so long as the influence took a zigzag path via the intersecting past light cones of the measurements in question. This suggestion is related to the so-called 'retrocausal' loophole in Bell's Theorem, but like that loophole it receives little attention, and remains poorly understood. In this talk I present a new argument for Costa de Beauregard's zigzag (now generalized in recent work by Leifer and Pusey), and discuss its relation to the motivation stemming from EPR and Bell.

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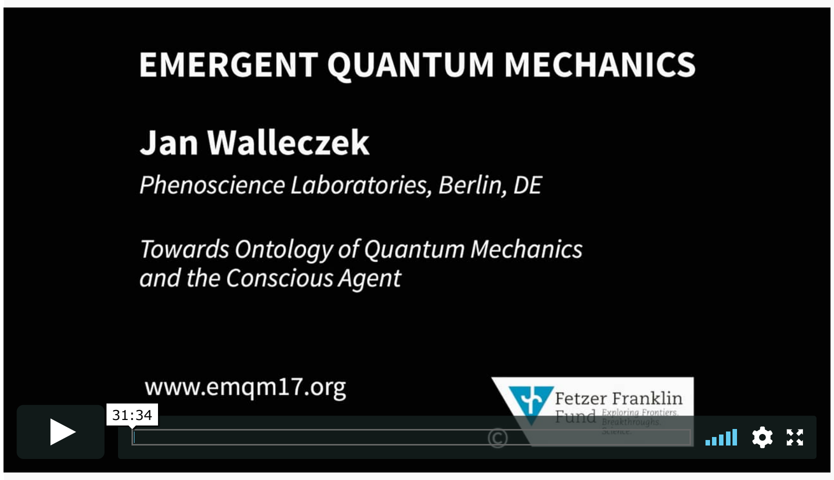
TOWARDS ONTOLOGY OF QUANTUM MECHANICS AND THE CONSCIOUS AGENT

Jan Walleczek



This introductory talk will provide an overview of the general topics to be covered by the Emergent Quantum Mechanics symposium (EmQM17) which explores the possibility of an ontology for quantum mechanics. Specifically, the symposium will offer an open forum for critically evaluating the prospects and significance – for 21st century physics – of ontological quantum mechanics, an approach which David Bohm helped pioneer. The resurgence of interest in realist approaches to quantum mechanics, including deterministic and indeterministic ones, challenges the standard textbook view. For example, standard “no-go” theorems against the possibility of realist, i.e., ontologically-grounded, quantum mechanics are increasingly recognized as falling short of their stated aim. Recent work also indicates that traditional assumptions and theorems such as nonlocality, contextuality, free choice, and non-signalling, need not necessarily contradict the existence of certain quantum ontologies.

In original de Broglie-Bohm theory, the mathematical formalism refers to hypothetical ontic elements (e.g., akin to John Bell’s “beables”) such as the quantum potential (Bohm, 1952). In the 21st century, realist quantum approaches often distinguish between ψ-epistemic and ψ-ontic ontological quantum theories. Unlike ψ-ontic theories, the ψ-epistemic theories do not view the wave function ψ as a state of reality. Nevertheless, both types of approaches posit—again—the possibility of an ontological foundation for quantum mechanics (Harrigan and Spekkens, 2010; Leifer, 2014).

Twenty-five years ago, David Bohm and Basil Hiley (1993) pointed out in the book “The Undivided Universe”, the close resemblance between key properties of deterministic, hidden-variable, pilot-wave theory and emergence theory, i.e., the theory describing the emergent formation of ordered (i.e., negentropic) states in nonlinear, self-organizing systems, such as deterministic chaos. The notion of ‘emergence’, when applied in the context of an EmQM, often entails two meanings: (1) theory emergence, or (2) physical emergence. Theory emergence describes the idea that the results of orthodox quantum theory might be derived from a more general, deeper-level (sub-)quantum theory. More specifically, the notion of ‘physical emergence’ in quantum systems holds that the orthodox quantum view is neither complete nor fundamental but that an as-yet unknown (sub-) quantum ontology might exist. Consequently, essential questions directing the EmQM research agenda are: Is reality intrinsically random or fundamentally interconnected? Is the universe local or nonlocal? What is the role of the conscious experimenter agent in quantum measurements? Might a radically new conception of reality include a new form of “quantum causality”?

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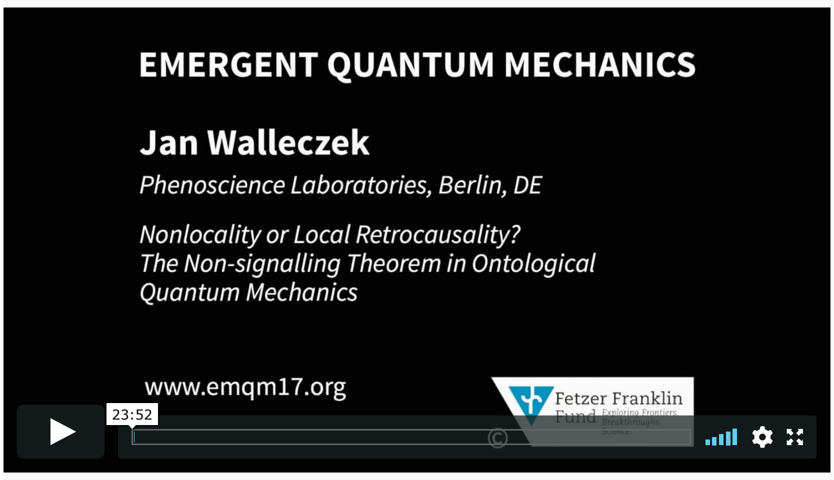
NONLOCALITY OR LOCAL RETROCAUSALITY? – THE NON-SIGNALLING THEOREM IN ONTOLOGICAL QUANTUM MECHANICS

Jan Walleczek



How to interpret the non-signalling theorem in time-symmetric quantum ontologies, including those that posit retrocausal influences from the future? To answer that question, I will first explain how the non-signalling theorem is to be interpreted in strictly nonlocal quantum ontologies, including in de Broglie-Bohm (dBB) theory. The non-signalling theorem is thought to ensure the compatibility of quantum theory with special relativity by preventing the possibility of causal paradox. Crucially, for ontological quantum mechanics, any thorough analysis of the non-signalling constraint needs to distinguish between these three concepts: (1) causality and causal influence, (2) information and information transfer, and (3) signalling and message communication (see Walleczek and Grössing, 2016). Unfortunately, the standard literature on quantum foundations often conflates these concepts leading to false conclusions about the impossibility of dBB-theory and of quantum-causal ontologies in general. For example, the standard (axiomatic) interpretation of the non-signalling theorem is wholly incompatible with dBB-theory (e.g., Walleczek and Grössing, 2014, 2016). That is, the AXIOMATIC position on non-signalling denies the existence of any (local or nonlocal) causal influences, i.e., an axiomatic non-signalling theorem represents a general "NO-INFLUENCE" theorem (Walleczek and Grössing, 2014). Therefore, an EFFECTIVE non-signalling theorem must be adopted in the context of ontological quantum theories, including for dBB-theory. Importantly, EFFECTIVE non-signalling denies only the superluminal transmission of Shannon signals, while – at the same time – enables the transmission of non-Shannon signals between spacelike-separated locations in EPR-type experiments. For the definition of SHANNON SIGNALLING see Walleczek and Grössing (2016).

Furthermore, when assuming the FREE CHOICE of the experimenter agent, an axiomatic non-signalling theorem has often been employed in orthodox quantum interpretations as an argument against the possibility of determinism and realism in quantum mechanics, including dBB-theory. However, I have recently shown that this often-repeated argument is logically incoherent due to the fallacy of circular reasoning which is captured in the notion of SUPER-INDETERMINISM (see Walleczek, 2016).

Finally, is there any advantage of the (local) RETROCAUSAL interpretation over the strictly NONLOCAL interpretation in view of the compatibility issue between quantum and relativity theories? This presentation will apply insights from the prior analysis of the EFFECTIVE non-signalling theorem to recent proposals of retrocausal quantum ontologies, for which must be prohibited the possibility of RETRO-SIGNALLING (i.e., of message transfers from the future to the past) in order to prevent causal paradox.

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Walleczek, J. and Grössing, G. (2016) Nonlocal Quantum Information Transfer Without Superluminal Signalling and Communication. Found. Phys. 46, 1208-1228.

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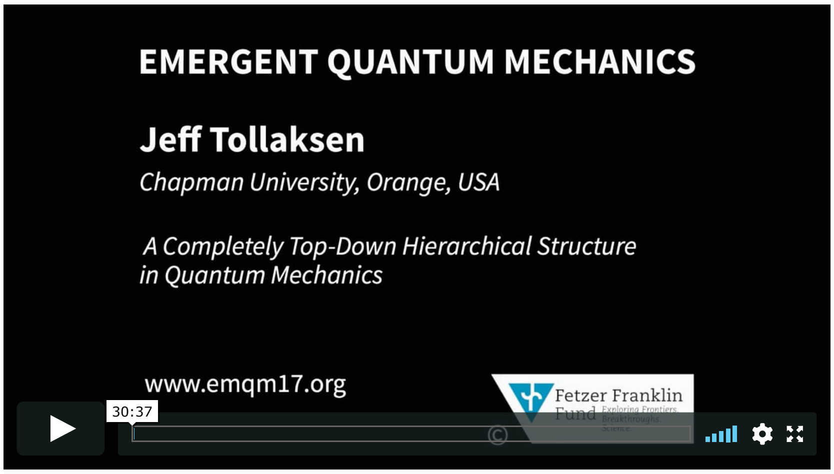
A COMPLETELY TOP-DOWN HIERARCHICAL STRUCTURE IN QUANTUM MECHANICS

Jeff Tollaksen



The organizers of this conference defined Emergent Quantum Mechanics as “a possible deeper-level theory that interconnects three fields of knowledge: emergence, the quantum, and information.” Therefore, in this talk, I first ask if it is always possible to completely reduce the behavior of a complex system to the behavior of its simplest atoms. I answer “No” in a new way by using pre- and post-selected many-particle systems. In particular, with an N-particle system, I show that local measurements such as “where is the particle?”, or “where is a pair of particles,” all the way up to “where is any N-1 particles” all provide null results. In addition, questions about any of the correlations between particles, up to the N-1 order correlations, also yield null results. However, we see emergence in the global properties of the whole (i.e. for all N particles), such as the emergence of strong nonlocal correlations. In addition, these high-order (i.e. N-body) correlations can determine lower-order ones, but not vice versa. Moreover, the latter seem to provide no information at all regarding the former. This supports a top-down structure in many-body quantum mechanics. Finally, I elaborate new types of complementarity, particularly those that show new perspectives concerning inner frames-of-reference versus outer.

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JEFF TOLLAKSEN

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Jeff Tollaksen is a Professor of Physics and Director of the Center for Excellence in Quantum Studies at Chapman University. He received his BA in physics from MIT. He later attended Boston University where he earned a MA and PhD in theoretical physics.

Before teaching at Chapman University, Tollaksen worked in the School of Computational Science at George Mason University. He has published over a dozen articles in various scientific journals and has conducted research via five grants on which he is the prime investigator.

(source: Chapman University)

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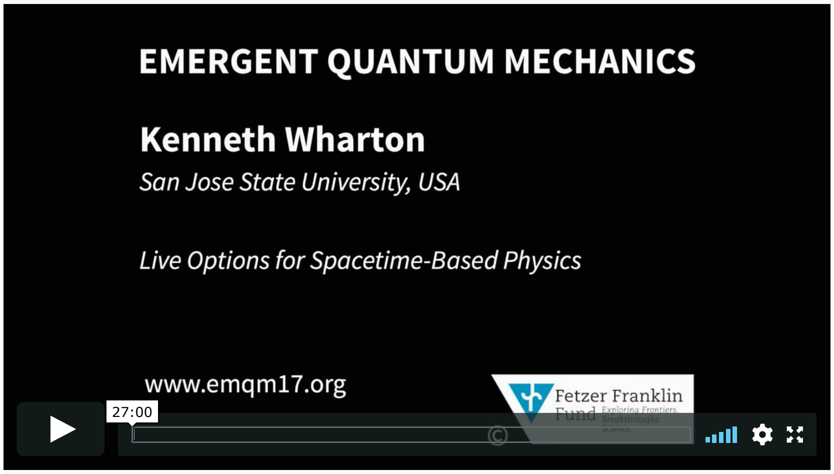
LIVE OPTIONS FOR SPACETIME-BASED PHYSICS

Ken Wharton



Entanglement places severe restrictions on the class of quantum models where all beables reside in ordinary spacetime. Nevertheless, it is worth examining such models in detail, in part because the alternative – trying to recover spacetime in some emergent limit – has proven to be so problematic. Taking the block-universe perspective of general relativity and classical field theory, the best options appear to be those in which any given spacetime system is solved “all-at-once”, as a four-dimensional boundary problem. Such approaches can even save a key form of locality (in the no-action-at-a-distance sense), entanglement notwithstanding, via the so-called “retrocausal loophole”. Recent progress and future prospects for such all-at-once/retrocausal physics models will be discussed.

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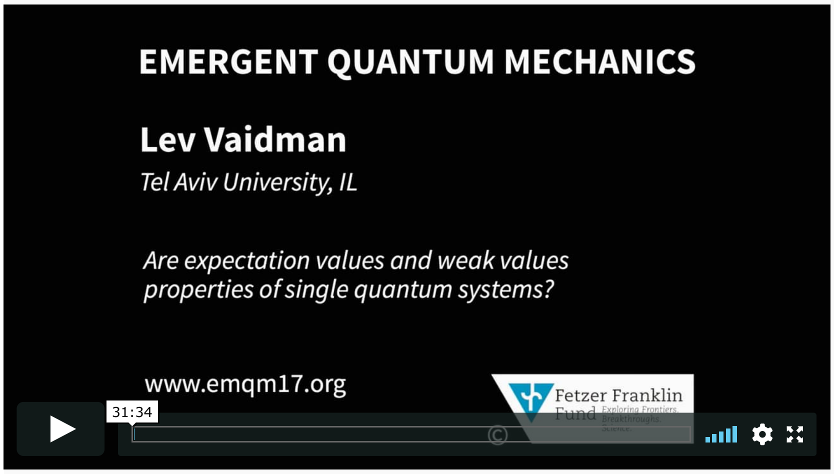
ARE EXPECTATION VALUES AND WEAK VALUES PROPERTIES OF SINGLE QUANTUM SYSTEMS?

Lev Vaidman



Two recent experiments are described. In the first experiment a single click of a detector observing a single photon provides an expectation value of its polarization operator. Another experiment demonstrates that a photon described by a weak value affects other systems much more like a photon described by an eigenvalue rather than a photon described by an expectation value. Physical meaning of results of these experiments is discussed.

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Determining the quantum expectation value by measuring a single photon. Fabrizio Piacentini, Alessio Avella, Enrico Rebufello, Rudi Lussana, Federica Villa, Alberto Tosi, Marco Gramegna, Giorgio Brida, Eliahu Cohen, Lev Vaidman, Ivo P. Degiovanni, and Marco Genovese. Nature Physics, doi:10.1038/nphys4223, Published online 14 August 2017.

Weak value beyond conditional expectation value of the pointer readings. Lev Vaidman, Alon Ben-Israel, Jan Dziewior, Lukas Knips, Mira Weißl, Jasmin Meinecke, Christian Schwemmer, Ran Ber, and Harald Weinfurter. Physical Review A, accepted 30 August 2017.

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MARKUS ARNDT

Faculty of Physics and QuNaBioS, University of Vienna,

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Markus Arndt (* 14. September 1965 in Unkel) ist ein deutscher Physiker und Professor für Quantennanophysik an der Universität Wien.
Markus Arndt studierte von 1985 bis 1990 Physik in Bonn und München. Es folgten von 1991 bis 1994 Doktoratsstudien am Max-Planck-Institut für Quantenoptik in Garching; das Thema der Dissertation lautete Optical and magneto-optical spectroscopy of metal atoms in liquid and solid He-4. Von 1994 bis 1995 war Arndt wissenschaftlicher Mitarbeiter am Max-Planck-Institut für Quantenoptik, von 1999 bis 2002 Universitätsassistent am Institut für Experimentalphysik der Universität Wien, ebenda erfolgte 2002 seine Habilitation. Ab September 2004 war er Vertragsprofessor für Quantennanophysik an der Universität Wien. 2008 wurde er Universitätsprofessor für Quantennanophysik an der Fakultät für Physik der Universität Wien.
Markus Arndt ist verheiratet und hat zwei Söhne.

Im Jahr 2000 erhielt er den Erich-Schmid-Preis der österreichischen Akademie der Wissenschaften (ÖAW), gemeinsam mit G. Springholz, sowie den Fritz-Kohlrausch Preis der Österreichischen Physikalischen Gesellschaft (ÖPG). Im Jahr 2001 wurde er mit dem START-Preis des Fonds zur Förderung der wissenschaftlichen Forschung (FWF) ausgezeichnet, 2008 mit dem FWF Wittgensteinpreis Wittgensteinpreis. 2012 warb er einen Advanced Grant des Europäischen Forschungsrats (ERC) ein [3]. Im Jahr 2013 wurde ihm der Preis der Stadt Wien für Naturwissenschaften zuerkannt. 2014 wurde er zum korrespondierenden Mitglied im Inland der mathematisch-naturwissenschaftlichen Klasse der Österreichischen Akademie der Wissenschaften gewählt.

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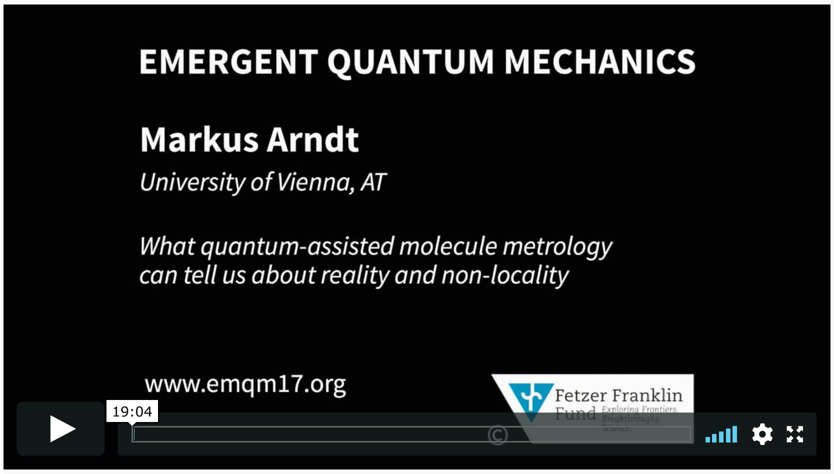
WHAT QUANTUM-INTERFERENCE ASSISTED MOLECULE METROLOGY CAN TELL US ABOUT REALITY AND NON-LOCALITY

Markus Arndt



Quantum physics stands for a series of dualities which have not yet been successfully cast into a universally accepted interpretation, since any one of them violates at least one principle of classical physics, such as our common notions of reality or locality. Single-molecule interferometry shows this dilemma in a particularly striking way, when it leads the eye of the observer to believe in the reality of composite particles, while at the same time showing that non-local information must exist. I will present recent experiments on advanced molecule metrology, that strongly suggest that molecular properties can be assigned a well-defined ontological meaning, even when the information about these properties seems to be available in regions of space-time that a point particle would never be able to explore. In that sense, matter-wave physics allows us to see the reality 'inside' of molecules even without observing these objects in the sense of 'knowing where they are'. Matter-wave interferometry seduces us to think in terms of Bohmian mechanics, like only few other experiments would do. However, it also cautions us that the world is more complex than we currently grasp in a single picture.

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MATT LEIFER

Institute for Quantum Studies and Schmid College of Science and Technology, Chapman University

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Matt Leifer is an academic who straddles the line somewhere between mathematics, philosophy, and theoretical physics. His main interests are in Quantum Information Theory and the Foundations of Quantum Theory.

He received his bachelors degree in Physics with Theoretical Physics from The University of Manchester in 1999, followed by a Masters of Advanced Study in Mathemaics (Maths Tripos part III) from the Department of Applied Maths and Theoretical Physics at the University of Cambridge in 2000, where he was a member of Girton College.

He studied for my Ph.D. in the School of Mathematics at the Univeristy of Bristol (2000-2003) under the supervision of Prof. Noah Linden, where I was a member of the Quantum Computing Group.

After a brief stint as a research assistant at Bristol, he arrived at Perimeter Institute as a Postdoctoral Fellow in January 2004, where he worked until September 2006. From October 2006, he was a research associate in the Centre for Quantum Computation at the University of Cambridge for three months. In January 2007, he arrived back in Waterloo for a second postdoctoral position, in which he was affiliated with the Institute for Quantum Computing and the Department of Applied Math at the University of Waterloo, and with the Perimeter Institute. The latter was due to a research grant from the Foundational Questions Institute.

Between April 2008 and August 2010, he was on leave of absence from work due to illness, after which he returned to work on a part time basis at University College London in the Quantum Information Group of the Physics and Astronomy department. Between December 2011 and August 2013, he was off work again due to illness. Since August 2013, he has returned to the Perimeter Institute as a long term visitor.

(source: Chapman University)

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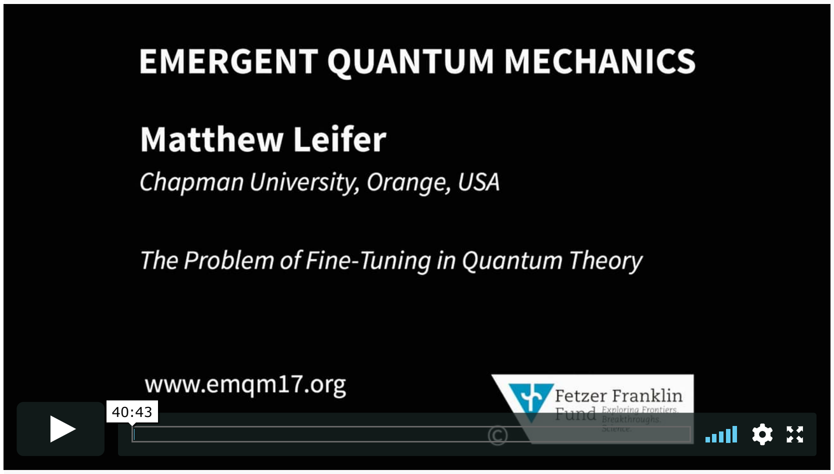
THE PROBLEM OF FINE-TUNING IN QUANTUM THEORY

Matt Leifer



Despite many years of research, there is still no universally agreed upon realist interpretation of quantum theory. In this talk, I will review the constraints that a good interpretation should satisfy, and argue that the main problem is to deal with the fine-tunings implied by no-go theorems about realist approaches to quantum theory, such as Bell's theorem. We should seek to either eliminate these fine tunings or explain them as emergent. I will give an overview of the various fine-tunings that exist in quantum theory, due to nonlocality, contextuality, lack of time-symmetry, and results on the reality of the quantum state. I will explain how we can quantify each fine tuning, and outline two approaches to solve the fine-tuning problem based on block universe models with retrocausality and many-worlds.

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MAURICE DE GOSSON

University of Vienna, Faculty of Mathematics, NuHAG

Maurice A. de Gosson also known as Maurice Alexis de Gosson de Varennes is an Austrian mathematician and mathematical physicist, born in 1948 in Berlin. He is currently a Senior Researcher at the Numerical Harmonic Analysis Group (NuHAG) of the University of Vienna.

After completing his PhD in microlocal analysis at the University of Nice in 1978 under the supervision of Jacques Chazarain, de Gosson soon became fascinated by Jean Leray's Lagrangian analysis. Under Leray's tutorship de Gosson completed a Habilitation à Diriger des Recherches en Mathématiques at the University of Paris 6 (1992). During this period he specialized in the study of the Leray-Maslov index and in the theory of the metaplectic group, and their applications to mathematical physics. In 1998 de Gosson met Basil Hiley, who triggered his interest in conceptual question in quantum mechanics. Basil Hiley wrote a foreword to de Gosson's book The Principles of Newtonian and Quantum Mechanics (Imperial College Press, London). After having spent several years in Sweden as Associate Professor and Professor in Sweden, de Gosson was appointed in 2006 at the Numerical Harmonic Analysis Group of the University of Vienna, created by Hans Georg Feichtinger (see www.nuhag.eu). He currently works in symplectic methods in harmonic analysis, and on conceptual questions in quantum mechanics, often in collaboration with Basil Hiley.

Maurice de Gosson has held longer visiting positions at Yale University, University of Colorado in Boulder (Ulam Visiting Professor), University of Potsdam, Albert-Einstein-Institut (Golm), Max-Planck-Institut für Mathematik (Bonn), Université Paul Sabatier (Toulouse), Jacobs Universität (Bremen).

Maurice de Gosson was the first to prove that Mikhail Gromov's symplectic non-squeezing theorem (also called „the Principle of the Symplectic Camel") allowed the derivation of a classical uncertainty principle formally totally similar to the Robertson-Schrödinger uncertainty relations (i.e. the Heisenberg inequalities in a stronger form where the covariances are taken into account). This rather unexpected result was discussed in the media.

In 2004/2005, de Gosson showed that Gromov's non-squeezing theorem allows a coarse graining of phase space by symplectic quantum cells, each described by a mean momentum and a mean position. The cell is invariant under canonical transformations. De Gosson called such a quantum cell a quantum blob: *"The quantum blob is the image of a phase space ball with radius by a (linear) symplectic transformation"* and *"Quantum blobs are the smallest phase space units of phase space compatible with the uncertainty principle of quantum mechanics and having the symplectic group as group of symmetries. Quantum blobs are in a bijective correspondence with the squeezed coherent states from standard quantum mechanics, of which they are a phase space picture."*

Their invariance property distinguishes de Gosson's quantum blobs from the "quantum cells" known in thermodynamics, which are units of phase space with a volume of the size of Planck's constant h to the power of 3.

De Gosson's notion of quantum blobs has given rise to a proposal for a new formulation of quantum mechanics, which is derived from postulates on quantum-blob-related limits to the extent and localization of quantum particles in phase space; this proposal is strengthened by the development of a phase space approach that applies to both quantum and classical physics, where a quantum-like evolution law for observables can be recovered from the classical Hamiltonian in a non-commutative phase space, where x and p are (non-commutative) c-numbers, not operators.

(source: Wikipedia)

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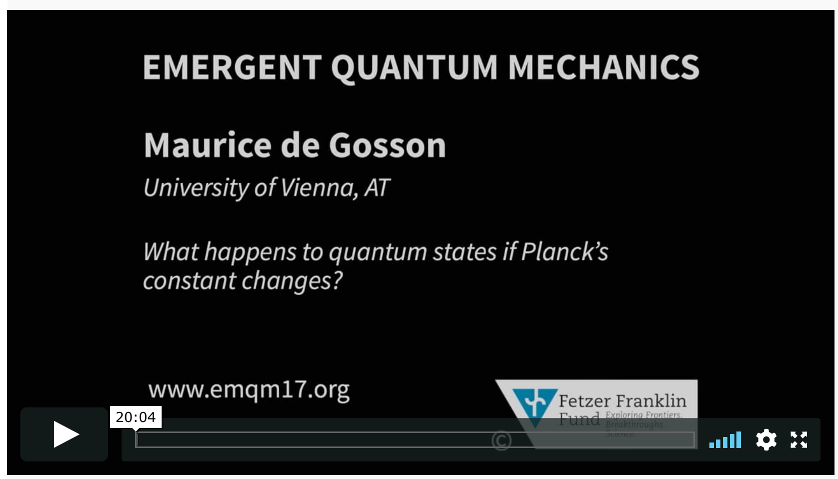
Maurice de Gosson



The variability of physical "constants" is a possibility that cannot be ruled out and which is an active area of research in cosmology and astrophysics. In fact, since Dirac in his "Large Numbers Hypothesis" suggested that some constants of Nature could vary in space and time, the topic has fascinated not only physicists but also philosophers of science and has motivated numerous theoretical and experimental findings. In this talk, we focus on the quantum mechanical consequences of possible changes in Planck's constant and show that the purity of a quantum state is extremely sensitive to such changes, but that quantum states can evolve into classical states, and vice versa. A complete classification of such transitions is however not possible for the moment because of yet unsolved mathematical difficulties related to the study of positivity properties of trace class operators. Reference: M. de Gosson, Phys. Lett. A 381 (2017).

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Max Tegmark

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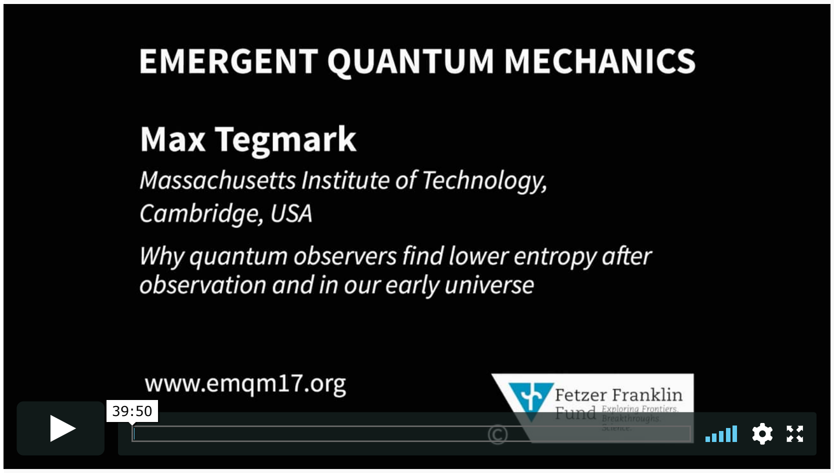
WHY QUANTUM OBSERVERS FIND LOWER ENTROPY AFTER OBSERVATION AND IN OUR EARLY UNIVERSE?

Max Tegmark



I describe how a tripartite subject-object-environment decomposition of a unitary quantum system combines decoherence and the Quantum Bayes Theorem into a simple unified picture where decoherence increases entropy while observation decreases it. This provides a rigorous quantum-mechanical version of the second law of thermodynamics, governing how the entropy of a system (the entropy of its density matrix, partial-traced over the environment and conditioned on what is known) evolves under general decoherence and observation, and it elegantly explains how cosmological inflation produces the low-entropy early universe that drives our perceived arrow of time.

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Profile

MAX TEGMARK

Department of Physics, Massachusetts Institute of Technology

A native of Stockholm, Tegmark left Sweden in 1990 after receiving his B.Sc. in Physics from the Royal Institute of Technology (he'd earned a B.A. in Economics the previous year at the Stockholm School of Economics).

His first academic venture beyond Scandinavia brought him to California, where he studied physics at the University of California, Berkeley, earning his M.A. in 1992, and Ph.D. in 1994. After four years of west coast living, Tegmark returned to Europe and accepted an appointment as a research associate with the Max-Planck-Institut für Physik in Munich. In 1996 he headed back to the U.S. as a Hubble Fellow and member of the Institute for Advanced Study, Princeton.

Tegmark remained in New Jersey for a few years until an opportunity arrived to experience the urban northeast with an Assistant Professorship at the University of Pennsylvania, where he received tenure in 2003. He extended the east coast experiment and moved north of Philly to the shores of the Charles River (Cambridge-side), arriving at MIT in September 2004. He is married to Meia-Chita Tegmark and has two sons, Philip and Alexander.

Tegmark is an author on more than two hundred technical papers, and has featured in dozens of science documentaries. He has received numerous awards for his research, including a Packard Fellowship (2001-06), Cottrell Scholar Award (2002-07), and an NSF Career grant (2002-07), and is a Fellow of the American Physical Society. His work with the SDSS collaboration on galaxy clustering shared the first prize in Science magazine's "Breakthrough of the Year: 2003."

(source: The Conversation Trust (UK) Limited)

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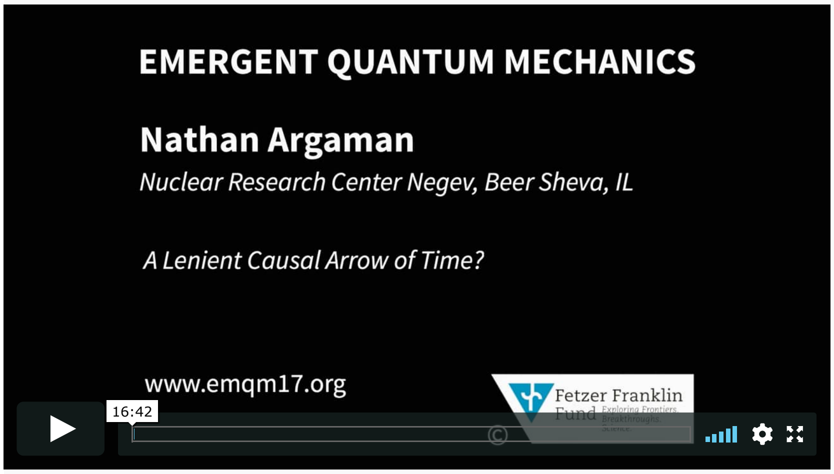
A LENIENT CAUSAL ARROW OF TIME?

Nathan Argaman



The literature on Bell's theorem includes much discussion of different definitions of locality, e.g., Bell's locality vs. signal locality, or parameter independence vs. outcome independence. In contrast, Bell's reviews of the topic identify "locality" with "local causality," which is a mathematical condition representing the causal arrow of time. Elsewhere, the role of an arrow of time as an assumption leading to Bell's theorem is downplayed, or completely omitted. An exception is the work of Huw Price, which requires complete time-reversal symmetry. It is argued that the time is ripe to seek mathematical theories in which neither the causal arrow of time nor time-reversal symmetry hold in a strict manner. As an example, the possibility that time-reversal symmetry is broken by a low-entropy-in-the-past condition is considered. For classical theories, those in which the state of the system at one time determines the state at other times, such symmetry-breaking leads to a strict causal arrow of time. For stochastic theories, the situation is less clear, but the emergence of an arrow of time for information is an intriguing possibility. The conclusion is that candidates for a "deeper-level theory" for Quantum Mechanics can only be stochastic theories with a "lenient" causal arrow of time.

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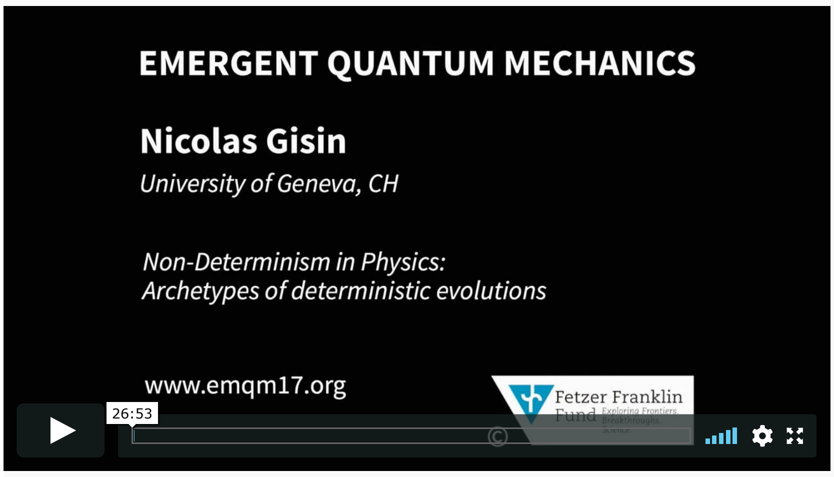
NON-DETERMINISM IN NEWTONIAN MECHANICS AND THE CLASSICAL "MEASUREMENT" PROBLEM

Nicolas Gisin



Starting from the hypothesis that a finite volume of space can't hold more than a finite amount of information, I argue that the mathematical real numbers are physically unreal. Indeed, almost all so-called real numbers contain an infinite amount of information, like, e.g., the answers to all questions one may formulate in any human language. Moreover, all real numbers, except a countable subset, are incomputable in the sense that their digits are random. Hence, a better name for them is random numbers. This name illustrates the fact that determinism can't be based on the use of "real" numbers to represent initial conditions. Hence, Newtonian classical mechanics is not deterministic, contrary to standard claims and beliefs, except for stable systems like harmonic oscillators. However, the use of the mathematical real numbers is undoubtedly very useful as an idealization to allow for, e.g., differential equations. But one should not make the confusion of believing that this idealization implies that nature herself is deterministic: A deterministic theoretical model of physics doesn't imply that nature is deterministic.

Consequently, in most physical dynamical systems, i.e. in chaotic systems, the initial conditions are random: after some determined initial digits, the next digits are undetermined (they don't have any ontological existence). Pretty soon, these random digits drive the system. This raises the question as to when the undetermined digits get actualized, i.e. get determined. This is the classical analog of the well-known quantum measurement problem. I argue that such a problem arises in all non-deterministic models.

The non-determinism of classical physics, as well as the non-determinism of quantum physics, imply that time really passes (arXiv:1602.01497). Einstein identified time with classical clocks, i.e. with classical harmonic oscillators. This, as well as the quantum unitary evolution, leads to what I call the boring time, the time when nothing truly new happens, the time when things merely are, time when what matters is being, i.e. Parmenides-time. But intrinsic indeterminism implies that there is another time, at least as real as Parmenides boring time, which I like to call creative time, or Heraclitus-time, when what matters is change.

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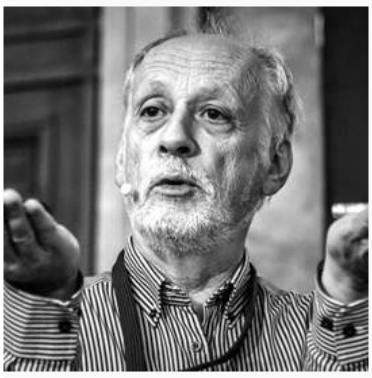
NICOLAS GISIN

Group of Applied Physics, University of Geneva



Professor Nicolas Gisin was born in Geneva, Switzerland, in 1952. After a master in physics and a degree in mathematics, he received his Ph.D. degree in Physics from the University of Geneva in 1981 for his dissertation in quantum and statistical physics. The "Fondation Louis de Broglie" recognised this work with an award.

After a post-doc at the University of Rochester, NY, he joint a start-up company, Alphatronix, dedicated to fiber instrumentation for the telecommunication industry. Initially head of the software, he quickly became responsible for the hardware-software interface. Four years later he joined a Swiss software company developing an image processing package which received the attention of the American journal "PC Magazine".

In 1988 an opportunity to join the Group of Applied Physics at the University of Geneva as head of the optics section brought him back to the academic life. At the time the optics section was entirely devoted to support of the Swiss PTT (now Swisscom). In order to get a critical mass and stability, the optics section under the impulse of Prof. N. Gisin started two new research directions, one in optical sensors, one in quantum optics. The telecom and the sensing activities led to many patents and technological transfers to Swiss and international industries. Several products had and still have a commercial success. The quantum optics activities are more basic research oriented. The main theme is to combine the large expertise of the group in optical fibers with basic quantum effects. More recently, the demonstration of quantum cryptography and of long distance quantum entanglement received quite a lot of attention as well from the international scientific community as from the press "grand public".

In 2009, he was awarded the First Biennial John Stewart Bell Prize for Research on Fundamental Issues in Quantum Mechanics and their Applications.

(source: Université de Genève)

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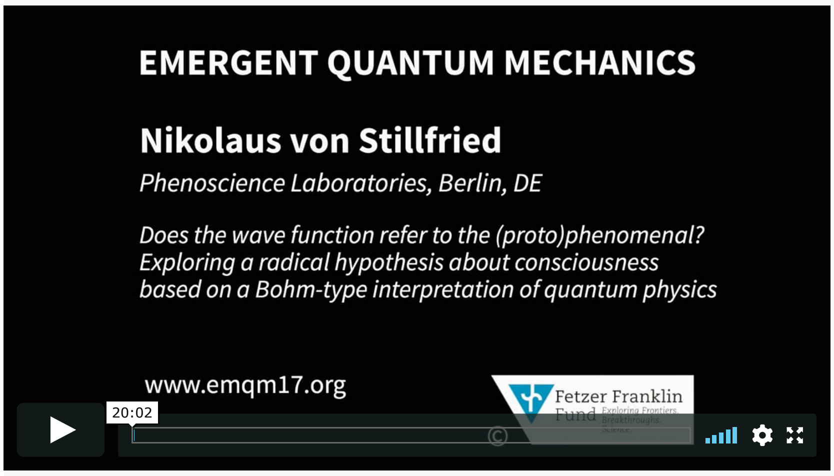
DOES THE WAVE FUNCTION REFER TO THE (PROTO)PHENOMENAL? EXPLORING A RADICAL HYPOTHESIS ABOUT CONSCIOUSNESS BASED ON A BOHM-TYPE INTERPRETATION OF QUANTUM PHYSICS

Nikolaus von Stillfried



In this talk I outline two major ways in which an ontic non-collapse interpretation of the wave function, such as the one proposed by David Bohm, is exciting for philosophers in search of a theory of consciousness. Firstly: The so called combination problem is generally seen as a major objection to panprotopsychist approaches such as 'Russelian Monism'. But if the wave function refers to a fundamental element of reality this problem does not arise, because the wave functions of individual interacting quanta are combined in a joint wave function. Secondly: A distinct ontic category seems required to account for the element of reality to which the wave function refers. The precise nature of this ontic category is still subject to much debate. David Bohm pioneered the idea that it might be protophenomenal when he spoke about the possibility that "even an electron has at least a rudimentary mental pole, represented mathematically by the quantum potential." (Bohm, 1990, p. 284; Bohm and Hiley, 1993, p. 381). This proposal combines the advantages of dualism and physicalism by assigning to consciousness an irreducible ontic category without having to expand our model of reality. As with all existing theories of consciousness, its main problems to date lie in a lack of both empirical testability and established logical necessity.

References: Bohm, D.J. (1990) A new theory of the relationship of mind and matter. Philosophical Psychology 3(2/3): 271-286.

Bohm, D.J. and Hiley, B.J. (1993) The Undivided Universe: An ontological interpretation of quantum theory. London and New York: Routledge.

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Profile

PAAVO PYLKKÄNEN

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Paavo Pylkkänen, Ph.D., is Senior Lecturer in Theoretical Philosophy and Director of the Bachelor's Program in Philosophy at the University of Helsinki. He is also Associate Professor of Theoretical Philosophy (currently on leave) at the Department of Cognitive Neuroscience and Philosophy, University of Skövde, where he initiated a Consciousness Studies Program.

His main research areas are philosophy of mind, philosophy of physics and their intersection. The central problem in philosophy of mind is how to understand the place of mind – and especially conscious experience – in the physical world. Pylkkänen has explored whether this problem can be approached in a new way in the framework of the new holistic and dynamic worldview that is emerging from quantum theory and relativity. He has in particular been inspired by the physicists David Bohm and Basil Hiley's interpretation of quantum theory and has collaborated with both of them.

In his 2007 book Mind, Matter and the Implicate Order (Springer) he proposed that Bohmian notions such as active information and implicate order provide new ways of approaching key problems in philosophy of mind, such as mental causation and time consciousness. The overall aim of his research is to develop a scientific metaphysics. Paavo Pylkkänen has been a visiting researcher in Stanford University, Oxford University, London University, Charles University Prague and Gothenburg University and is a member of the Academy of Finland Center of Excellence in the Philosophy of Social Sciences (TINT).

(source: Wikipedia)

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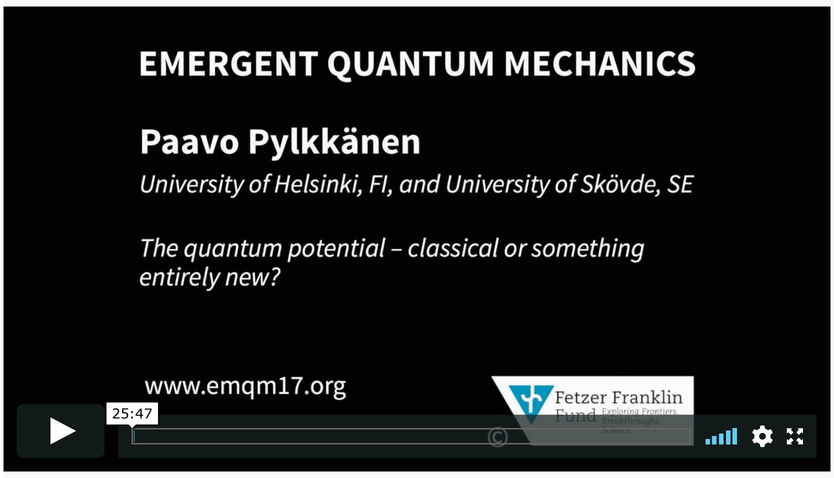
THE QUANTUM POTENTIAL – CLASSICAL OR SOMETHING ENTIRELY NEW?

Paavo Pylkkänen



A common criticism of Bohm's 1952 causal (quantum potential) interpretation of quantum theory – even among Bohmians – is that it is trying to force quantum phenomena into a classical physics framework, thus diluting the quantum revolution. However, especially in his later work Bohm emphasized the radically non-classical nature of the quantum potential Q. It is true that in this approach the basic equation of motion [i.e., m × dv/dt = grad (V) – grad (Q)] has the form of Newton's laws. However, Bohm argued that this form alone is not enough to determine that the general structure of classical physics will hold. To obtain determinism in Newtonian physics, one has to assume certain restrictions on the forces. However, the quantum potential approach goes beyond such restrictions and thus an entirely new kind of physical law is implied. For one thing, Q depends only upon the form, or the second spatial derivative of the amplitude R of the ψ-field. This form, in turn, reflects the form of the environment (such as the presence of slits). Could it be that the ψ-field is literally "in-forming" or putting form into the activity of the particle, rather than pushing and pulling the latter mechanically? Bohm and Hiley called this "active information", because here information acts to bring about changes in the behaviour of the particle. Note also that we can now make sense of the notorious multi-dimensionality of the ψ-field for the many-body system. For here the wave function describes an information structure that can quite naturally be considered to be multidimensional. The approach also has holistic features that go beyond classical physics. In the case of a single particle, because Q only depends upon the form of the ψ-field, it does not necessarily fall of even if the intensity of the ψ-field becomes weak as the field spreads out. This means that even very distant features of the environment (e.g. slits) can have a strong effect upon the particle. More radically, for a many-body system the forces as determined by Q depend on a quantum field of active information ordered in the 3N-dimensional configuration space. This involves a non-local connection between particles that depends on the quantum state of the whole, in a way that cannot be expressed in terms of the relationships of the particles alone. Such priority of the whole goes strongly against the mechanistic spirit of classical physics. Moreover, the idea that information (which can be seen as a primitive mind-like quality) might play a role at the quantum level is potentially important for many philosophical problems, as Bohm himself observed. For example, the extension of Bohm's quantum ontology seems to enable a new view of mental causation, i.e. how mental states might have genuine causal efficacy. This paper discusses the notion of active information and its potential relevance to philosophy of mind. (https://philpapers.org/profile/8537)

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Profile

PETER BARKER

Department of Physics and Astronomy, University College London

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Peter Barker got a background in atomic and molecular laser spectroscopy, non-linear optics, and laser trapping and cooling. Within the last 10 years his research has concentrated on the study of molecular cooling and trapping and on quantum cavity optomechanics. He has expertise in developing applications from more basic optical physics research.

He was awarded a PhD in Physics from the University of Queensland, Australia in 1996. From 1997 to 2001 he was a Postdoctoral Research Associate, and then a Research Scientist and Lecturer in the Applied Physics Group in the Mechanical and Aerospace Engineering Department at Princeton University. At Princeton, I began to study the manipulation of atoms and molecules in pulsed optical fields by studying coherent Rayleigh scattering from molecules trapped in optical lattices. During his time he was part of a multidisciplinary team of physicists and engineers from Princeton University, Sandia National Laboratories and Lawrence Livermore developing a new type of wind tunnel for accelerating gases to hypersonic speeds using lasers and electron beams. In 2001 he took up the position of Lecturer in the Physics Department at Heriot-Watt University and became a Senior Lecturer in 2004. In October 2006 he joined the AMOP group at UCL as a Reader and was promoted to Professor in October 2007. Currently he has projects in cavity optomechanics using nanoparticles levitated in vacuum and larger microscale clamped systems based on whispering gallery mode resonators for studying fundamental quantum mechanics and for development of sensors.

(source: University College London)

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WEAK MEASUREMENTS OF ATOMIC MOMENTUM

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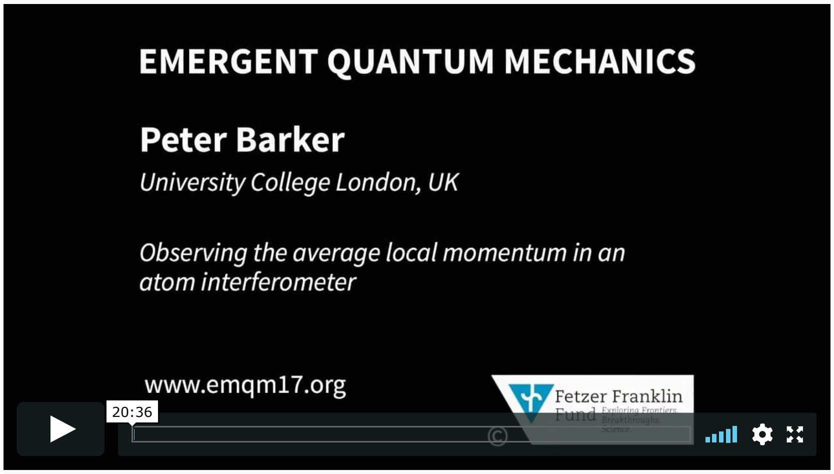

There is considerable interest in the use of weak measurements to explore fundamental quantum processes and for quantum metrology. In this talk I will describe our experiments which aim to make a weak measurement of atomic momentum using a cold-atom, matter-wave interferometer. I will describe our matter-wave interferometer that uses laser cooled argon atoms to perform these measurements. In this scheme, cold atoms are first produced in a magneto-optical trap before radiation pressure is utilised to form a slow atomic beam that is directed through an optical grating. I will describe how we will use this system to reconstruct the atomic trajectories within the interferometer where the pointer that weakly couples to momentum is the spin of the 5 Zeeman states of the laser-cooled metastable (4S[3/2]2) argon atoms.

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(source: University College London)

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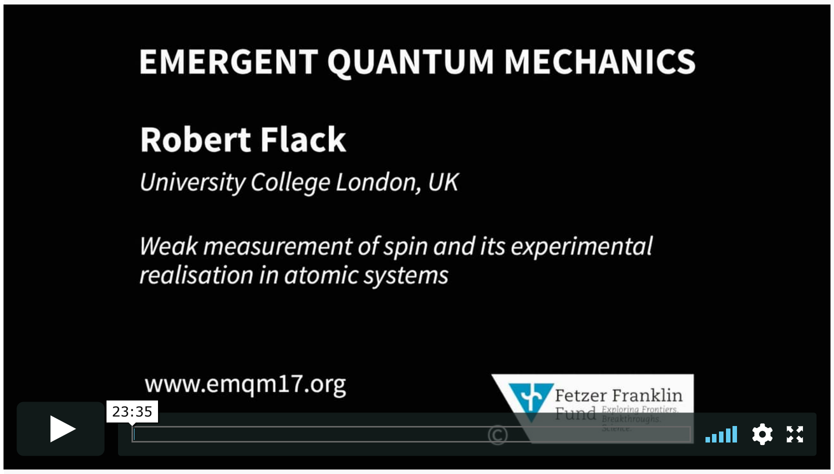
WEAK MEASUREMENT OF SPIN AND ITS EXPERIMENTAL REALISATION IN ATOMIC SYSTEMS

Robert Flack



Weak values have a long history and were first considered by Landau and London in connection with superfluids. Hirschfelder called them sub-observables and Dirac anticipated them when discussing non-commutative geometry in quantum mechanics. The idea of a weak value has returned to prominence due to Aharonov, Albert and Vaidman showing how they can be measured. They are not eigenvalues of the system and cannot be measured by a collapse of the wave function with the traditional Von Neumann (strong) measurement which is a single stage process. In contrast the weak measurement process has three stages; preselection, weak stage and finally a post selection. Although weak values have been observed using photons and neutrons, we are building an experiment to observe a weak value of spin in an atomic system. We are using a method based on a variant of the original Stern-Gerlach experiment using a metastable, 23S1, form of helium. Two analyses have been carried out using the impulsive approximation and the Feynman propagator methods. They are in complete agreement. The design, simulation and realisation of the experiment will be presented.

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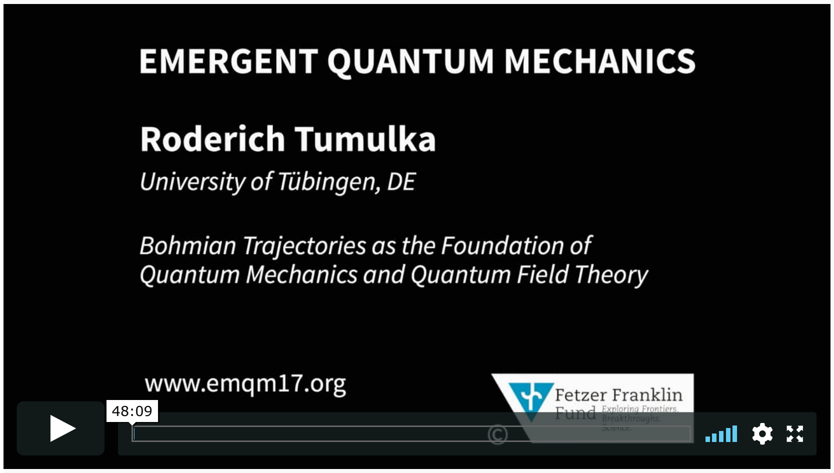
BOHMIAN TRAJECTORIES AS THE FOUNDATION OF QUANTUM MECHANICS AND QUANTUM FIELD THEORY

Roderich Tumulka



The biggest and most lasting among David Bohm's many achievements is to have proposed a picture of reality that explains the empirical rules of quantum mechanics. This picture, known as pilot wave theory or Bohmian mechanics among other names, is still the simplest and most convincing explanation available. According to this theory, electrons are point particles in the literal sense and move along trajectories governed by Bohm's equation of motion. In my talk, I will describe some more recent developments and extensions of Bohmian mechanics, concerning in particular relativistic space-time and particle creation and annihilation.

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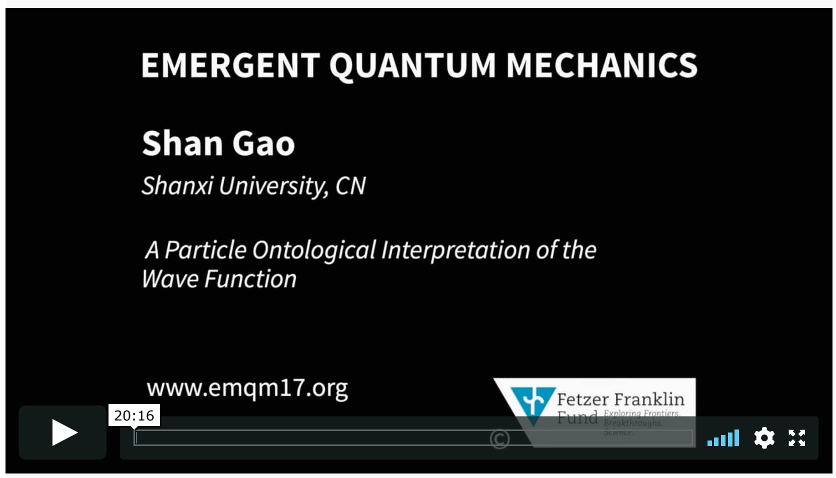
A PARTICLE ONTOLOGICAL INTERPRETATION OF THE WAVE FUNCTION

Shan Gao



The ontological meaning of the wave function is an important problem in the metaphysics of quantum mechanics. The conventional view is wave function realism, according to which the wave function represents a real physical field in a fundamental high-dimensional space. In this talk, I will introduce a new particle ontological interpretation of the wave function, which has been recently proposed in my book “The Meaning of the Wave Function: In Search of the Ontology of Quantum Mechanics” (CUP, 2017). According to this interpretation, a quantum system is a system of particles that undergo random discontinuous motion in our three-dimensional space, and the wave function of the system represents the instantaneous property of these particles that determines their random discontinuous motion. In particular, the modulus squared of the wave function represents the propensity property of the particles that determines the probability density that they appear in every possible group of positions in space. Moreover, I will argue that the difference between particle ontology and field ontology may result in different empirical predictions under certain reasonable assumption, and it is the former, not the latter, that is consistent with the predictions of quantum mechanics.

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Profile

SHAN GAO

Institute for the History of Natural Sciences, Chinese Academy of Sciences,

Shan Gao is Professor of Philosophy at the Research Center for Philosophy of Science and Technology, Shanxi University, and Visiting Professor at the University of Chinese Academy of Sciences.

He is the founder and managing editor of the International Journal of Quantum Foundations, and is the author of several books and the editor of the recent anthology Protective Measurement and Quantum Reality: Towards a New Understanding of Quantum Mechanics (Cambridge, 2015).

His research focuses on the foundations of quantum mechanics and the history of modern physics.

(source: Cambridge University Press)

VIDEOS WITH SHAN GAO

VIDEO

PHYSICS
A Particle Ontological Interpretation of the Wave Function

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Info

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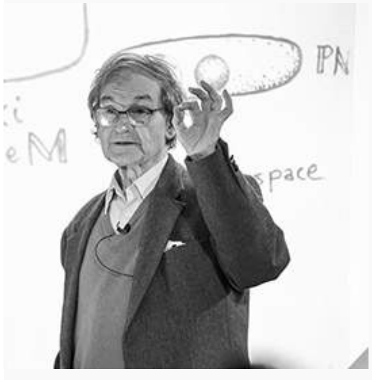
Profile

SIR ROGER PENROSE

Mathematical Institute, University of Oxford



Sir Roger Penrose, was born in England, in Colchester, August 8, 1931. His parents were both highly educated. His mother Margaret Feathe was a doctor, and his father, Lionel Sharples Penrose, was a medical geneticist who was elected a Fellow of the Royal Society. He and his brothers Oliver and Jonathan all went into the sciences. Jonathan became a psychologist, while Oliver, the eldest, became a mathematician.

In 1939 Roger's father went to the United States with his family but as all the indications pointed towards the outbreak of war, he decided not to return to England with his family but accepted an appointment in a hospital in London, Ontario, Canada. Roger attended school in London, Ontario but although it was during this period that he first became interested in mathematics it was not his schooling which stimulated this interest, rather it was his family.

Roger's father became Director of Psychiatric Research at the Ontario Hospital in London Ontario, but he was very interested in mathematics, particularly geometry, while Roger's mother was also interested in geometry.

In 1945, after the World War II ended, the Penrose family returned to England. Roger's father was appointed as Professor of Human Genetics at University College London and Roger attended University College School in London. Then his interest in mathematics began to increase but his family saw him following in his father's footsteps and taking up a medical career. However, as was typical in schools at this time, biology and mathematics were alternatives at the University College School with pupils having to choose one or the other.

Penrose entered University College London which he was entitled to do without paying fees since his father was professor there. He was awarded a B.Sc. degree with First Class Honours in Mathematics and then decided to go to Cambridge to undertake research in pure mathematics. He was following in the footsteps of his older brother Oliver who had also taken his undergraduate degree at University College London and had gone to Cambridge to undertake research but Oliver had chosen physics. Roger, however, was set on research in mathematics and on entering St. John's College he began research in algebraic geometry. Penrose was awarded his Ph.D. for his work in algebra and geometry from the University of Cambridge in 1957 but by this time he had already become interested in physics.

In 1964 Penrose was appointed as a Reader at Birkbeck College, London and two years later he was promoted to Professor of Applied Mathematics there. In 1973 he was appointed Rouse Ball Professor of Mathematics at the University of Oxford and he continued to hold this until he became Emeritus Rouse Ball Professor of Mathematics in 1998. In that year he was appointed Gresham Professor of Geometry at Gresham College, London.

His research interests include many aspects of geometry, having made contributions to the theory of non-periodic tilings, to general relativity theory and to the foundations of quantum theory.

While Penrose received his Ph.D. at Cambridge in algebraic geometry, he began to work on the problem of whether a set of shapes could be found which would tile a surface but without generating a repeating pattern (known as quasi-symmetry). Armed with only a notebook and pencil, Penrose set about developing sets of tiles that produce 'quasi-periodic' patterns; at first glance the pattern seems to repeat regularly, but on closer examination you find it is not quite so. Eventually he found a solution to the problem but it required many thousands of different shapes. After years of research and careful study, he successfully reduced the number to six and later down to an incredible two. It turned out this was a problem that couldn't be solved computationally.

Penrose triangleAlso, in 1954 he and his father published article in British Journal of Psychology about basic impossible figures: impossible triangle and endless staircase. In the article impossible triangle (also known as tribar) was represented in its common view with perspective effect. These impossible figures were used in lithographs of holland artist M.C. Escher.

Penrose believes thet the brain can execute processes that no possible Turing-type computer could carry out. He is famous for his books on consciousness such as "The Emporer's New Mind" (1989). He also considers physics incomplete because there is as yet no theory of quantum gravity. Penrose hopes that an adequate theory of quantum gravity might contribute to explain the nature and emergence of consciousness. In this sense, his main research program in physics is to develop the theory of twistors, which he originated over 30 years ago as an attempt to unite Einstein's general theory of relativity with quantum mechanics.

Sir Roger Penrose Penrose has received many honours for his contributions. He was elected a Fellow of the Royal Society of London (1972) and a Foreign Associate of the United States National Academy of Sciences (1998). The Science Book Prize (1990) which he received for The Emperor's New Mind but this is only one of many prizes. Others include the Adams Prize from Cambridge University; the Wolf Foundation Prize for Physics (jointly with Stephen Hawking for their understanding of the universe); the Dannie Heinemann Prize from the American Physical Society and the American Institute of Physics; the Royal Society Royal Medal; the Dirac Medal and Medal of the British Institute of Physics; the Eddington Medal of the Royal Astronomical Society; the Naylor Prize of the London Mathematical Society; and the Albert Einstein Prize and Medal of the Albert Einstein Society. In 1994 he was knighted for services to science.

In 18th January 2006 Sir Roger Penrose, Emeritus Rouse Ball Professor of Mathematics, has received the 2006 Communications Award of the Joint Policy Board for Mathematics (JPBM) in the US. Presented annually, the award recognises outstanding achievement in communicating about mathematics to nonmathematicians.

(source: Impossible World)

VIDEOS WITH SIR ROGER PENROSE

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Space-Time Quantum Non-Locality: Does Palatial Twistor Theory Suggest an...

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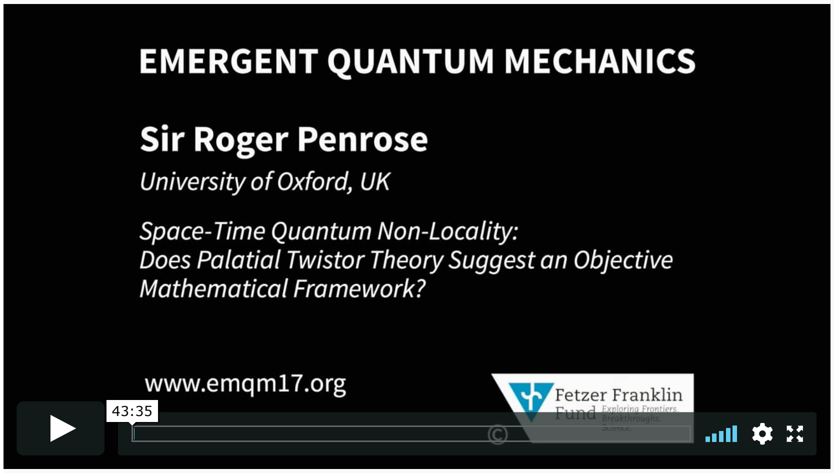
SPACE-TIME QUANTUM NON-LOCALITY: DOES PALATIAL TWISTOR THEORY SUGGEST AN OBJECTIVE MATHEMATICAL FRAMEWORK?

Sir Roger Penrose



An important initial motivation for twistor theory was David Bohm's version of the EPR conundrum which led to John Bell's convincing demonstration that quantum physics must be non-local in some deep sense. Twistor theory, subsequently led to a fundamentally non-local description of massless quantum particles. Recent developments suggest that a novel approach—palatial twistor theory—may eventually provide an objective non-local picture of general-relativistic quantum physics.

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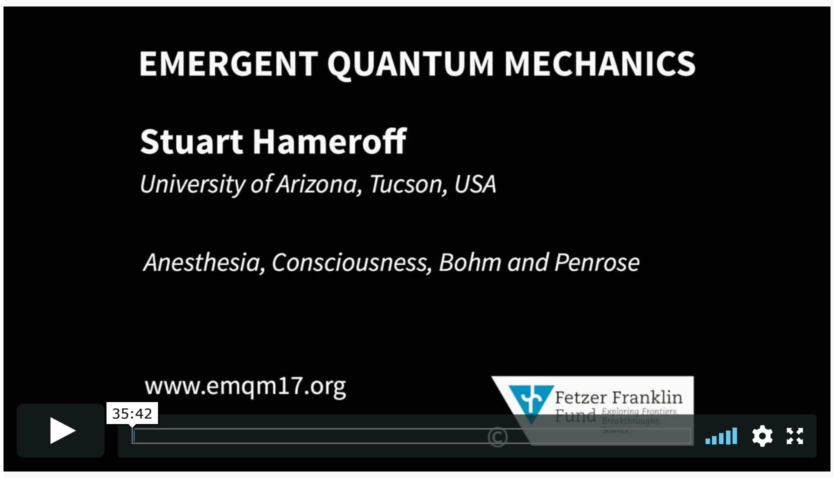
ANESTHESIA, CONSCIOUSNESS, BOHM AND PENROSE

Stuart Hameroff



David Bohm believed the brain utilized quantum mechanisms, and that conscious thought was distributed and non-local. Roger Penrose has proposed that consciousness involves quantum state reductions linked to an objective threshold intrinsic to spacetime geometry (objective reduction, 'OR'). For either, the brain must sustain quantum coherent superpositions long enough for cognitive functions. How can this happen? Perhaps the best approach is to pinpoint the action of anesthetic gases which selectively block consciousness, sparing non-conscious brain activities. In the 19th century a group of gases with diverse chemical structures were found to reversibly render humans and animals immobile, unresponsive and unconscious. These disparate 'anesthetic' gases bind by weak, quantum interactions known as van der Waals London dipole forces. Hans Meyer (1899) and Charles Overton (1901) found that anesthetic potency correlated with binding in non-polar, lipid-like regions (the 'Meyer-Overton correlation'). Subsequent work by Nick Franks and Bill Lieb (1984) showed anesthetics acted in such regions inside proteins, e.g. 'pi resonance' electron clouds of aromatic amino acid rings. Which proteins? Although membrane receptor and ion channel proteins were long thought to mediate anesthesia (and consciousness), evidence now points instead to microtubules inside neurons. Polymers of the protein tubulin, microtubules regulate neuronal synapses and membrane states, and have resonant oscillations in terahertz, gigahertz, megahertz and kilohertz. In Craddock et al (2017), we used computer modeling and quantum chemistry to simulate collective quantum dipole oscillations of pi resonance clouds of all 86 aromatic rings in tubulin. We found a spectrum of terahertz oscillation frequencies which included a prominent 'common mode' peak at 613 terahertz (in the visible blue light spectrum, but existing internally to the system without photoexcitation). We then re-simulated the collective tubulin quantum oscillations with each of 8 anesthetic gases, and 2 gases which bind in non-polar, pi resonance regions but do not cause anesthesia ('non-anesthetics'). We found that all 8 anesthetics abolished the 613 terahertz peak proportional to their potency, and that non-anesthetics had no effect, suggesting anesthetics prevent consciousness by dampening terahertz quantum oscillations in brain microtubules, supporting either a Bohmian approach, and/or the Penrose-Hameroff 'Orch OR' theory. In Orch OR, consciousness occurs due to 'orchestrated' ('Orch') quantum states and objective reductions ('OR') in microtubules which resonate through a multi-scale vibrational hierarchy to membrane and synaptic activities in hertz. A 'Meyer-Overton quantum underground' appears to support quantum states and brain function leading to consciousness.

Reference: Craddock TJA, Kurian P, Preto J, Sahu K, Hameroff SR, Klobukowski M, Tuszynski JA (2017) Anesthetic alterations of collective terahertz oscillations in tubulin correlate with clinical potency: Implications for anesthetic action and post-operative cognitive dysfunction. Nature – Scientific Reports 7(1): 9877. DOI:10.1038/s41598-017-09992-7.

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Profile

STUART HAMEROFF

Center for Consciousness Studies, Departments of Anesthesiology and Psychology, University of Arizona Health Sciences Center

Download vita

Stuart Hameroff MD grew up in Cleveland, Ohio, working summers at Republic Steel and Cleveland Stadium. At the University of Pittsburgh in the late 1960s, he studied chemistry, physics, mathematics and philosophy of mind. In medical school in the early 1970s at Hahnemann Medical College in Philadelphia, Hameroff spent a summer in a cancer research lab. Studying mitosis, he became interested in mitotic spindles and centrioles, composed of microtubules, polymers of the protein 'tubulin', and major components of the cytoskeleton within all cells. Comparing their lattice structure to Boolean computer matrices, he proposed that microtubules were the source of biological intelligence, and perhaps consciousness. Choosing an academic career, Hameroff trained in anesthesiology at the new University of Arizona Medical Center in Tucson, mentored by the department of anesthesiology's founding chair, Dr Burnell Brown Jr, MD, PhD. After residency, Hameroff joined the anesthesiology faculty in 1977, a position he still holds as emeritus professor and practicing anesthesiologist.

Hameroff's research pursues theory - brain mechanisms of consciousness, memory, anesthetic action, quantum processing in microtubules, and clinical applications - transcranial ultrasound (TUS) for various brain disorders.

In the mid 1990s Hameroff teamed with famed British physicist Sir Roger Penrose to develop a quantum theory of consciousness ('orchestrated objective reduction', 'Orch OR') based on microtubule quantum computing. Highly controversial and harshly criticized, Orch OR is now supported by evidence, e.g. that anesthetics act in quantum channels in microtubules, and that microtubules have multi-scalar resonances, e.g. in megahertz. Hameroff and Penrose wrote a 20 year review of Orch OR in 2014.

Megahertz mechanical vibrations are ultrasound, clinically used in anesthesiology, and Hameroff proposed low intensity, non-invasive ultrasound could stimulate microtubule megahertz resonance and improve mental and neurological states in the brain. He and anesthesiology colleagues performed and published the first clinical trial of transcranial ultrasound ('TUS') on mental states in human volunteers, showing mood enhancement from brief, low intensity TUS. Collaborative studies with psychology professor John JB Allen and post-doc Jay Sanguinetti corroborated and elaborated TUS effects, and more TUS clinical studies are planned for Alzheimer's disease, depression, traumatic brain injury (with Dr. Lemole in neurosurgery), Parkinsons (Dr. Scott Sherman in Neurology) and pediatric developmental delay (with Dr. Sydney Rice in pediatrics). The group will test a state-of-the-art TUS headset from Berkeley Ultrasound, sponsored and organized through the Center for Consciousness Studies.

Beginning in 1994, with professor and former department head Al Kaszniak in Psychology, the late professor Alwyn Scott in mathematics, and subsequently philosophy (and Regents) professor David Chalmers, Hameroff started an interdisciplinary, international conference series 'Toward a Science of Consciousness' held in even-numbered years in Tucson, and odd-numbered years elsewhere around the world. April 2014 marked the 20 year anniversary 'Tucson' conference, and the 2015 conference will be in in Helsinki, Finland in June.

In 1998, with Kaszniak and Scott, and a 1.4 million dollar grant from the Fetzer Institute, Hameroff co-founded the University of Arizona Center for Consciousness Studies (CCS), served as associate director, and succeeded Kaszniak and then Chalmers, as director in 2004. With CCS moving administratively to anesthesiology, and Abi Behar-Montefiore as assistant director, CCS has subsisted since 2004 entirely on conference registration fees and small grants, and has supported relevant research.

Hameroff also collaborates with professors Jack Tuszynski at the University of Alberta, and Travis Craddock at Nova Southeastern on molecular modeling of microtubules, memory via CaMKII phosphorylation, and non-polar anesthetic and psychoactive drug actions in microtubule 'quantum channels'. Quantum non-locality implied for consciousness has attracted interaction with Deepak Chopra, and the inaugural 'Rustum Roy' award in 2011.

Hameroff has written or edited 5 books, over a hundred scientific articles and book chapters, lectured around the world, and appeared in the film 'WhattheBleep?' and numerous TV shows about consciousness on BBC, PBS, Discovery, OWN and History Channel.

(source: The University of Arizona)

VIDEOS WITH STUART HAMEROFF

VIDEO

PHYSICS

Anesthesia, Consciousness, Bohm and Penrose

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SPEAKER
Thomas Filk

FIELD OF SCIENCE
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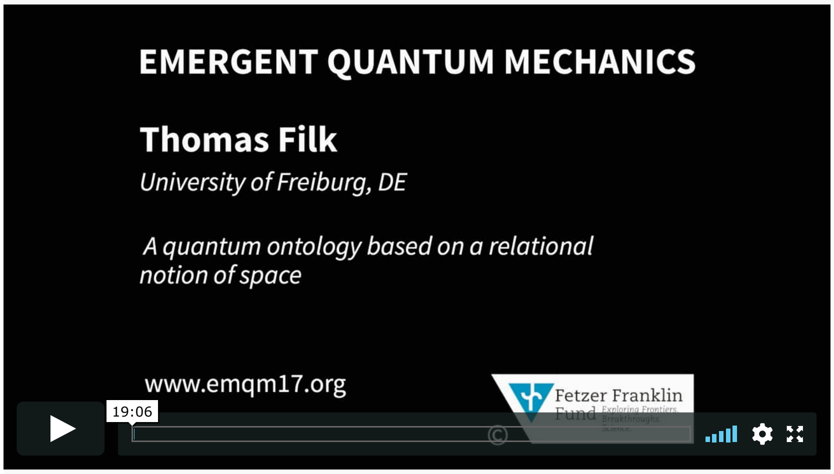
A QUANTUM ONTOLOGY BASED ON A RELATIONAL NOTION OF SPACE

Thomas Filk



Many so-called mysteries of quantum theory are related to our notions of “local” and “locality” in space. In most cases these notions are based on Newton’s ideas of space as a kind of “vessel” or “stage”, where matter “is at” a particular point. This view still holds in relativity (where events “happen at” a particular point). However, in the philosophy of science also alternative views of space (and time) have been proposed. Notably Descartes and Leibniz argued in favor of a relational space, in which the location of an object is not defined by “where it is” but “to which other entities it is related to”. Many mysteries of quantum mechanics (non-locality, summation over paths, the double-slit experiment, etc.) are more intuitive when viewed in this way.

In my talk I will sketch how this view might be extended to an ontology. Such an ontology (different from Bohmian mechanics) would support Bohm’s idea of “it is possible” and simultaneously show that Bohmian mechanics is not the only ontology which could reproduce the observed phenomenology and what is described by standard quantum theory.

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Profile

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Thomas Filk is a scientific associate at the Parmenides Center for the Study of Thinking and „Privatdozent" for Theoretical Physics, University of Freiburg

VIDEOS WITH THOMAS FILK

VIDEO

PHYSICS
A quantum ontology based on a relational notion of space

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Profile

TIM MAUDLIN

Department of Philosophy, New York University

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Tim Maudlin (B.A. Yale, Physics and Philosophy; Ph.D. Pittsburgh, History and Philosophy of Science) has interests primarily focused in the foundations of physics, metaphysics, and logic. His books include Quantum Non-Locality and Relativity (Blackwell, 3rd edition now available), Truth and Paradox (Oxford) and The Metaphysics Within Physics (Oxford). Philosophy of Physics: Space and Time is in press, and should be published in 2012 by Princeton University Press.

He is currently at work on a second volume for Princeton, and on a large project developing and applying an alternative mathematical account of topological structure. He is a member of the Academie Internationale de Philosophie des Sciences and the Foundational Questions Institute (FQXi). He has been a Guggenheim Fellow.

He taught at Rutgers from 1986 to 2011, and has been a visiting professor at Harvard.

(source: NYU College of Arts and Science)

VIDEOS WITH TIM MAUDLIN

VIDEO

PHYSICS
Ontological Clarity, Electromagnetism and the Aharanov-Bohm Effect

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SPEAKER
Tim Palmer

FIELD OF SCIENCE
Physics

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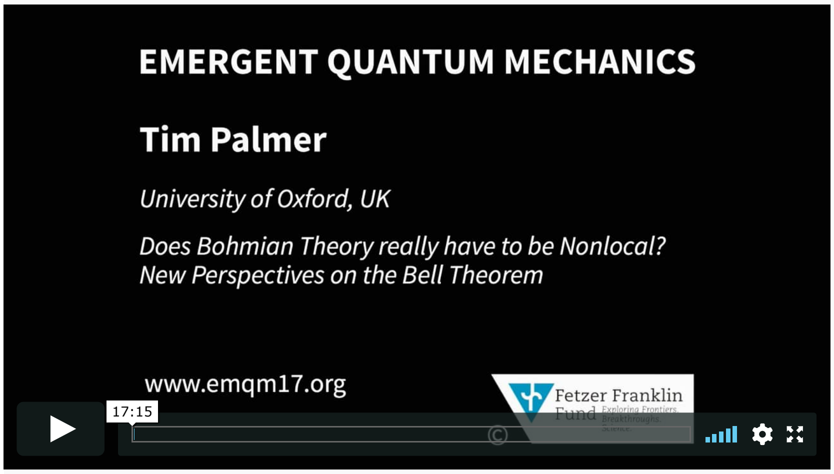
DOES BOHMIAN THEORY HAVE TO BE NONLOCAL? NEW DIRECTIONS FOR ANALYSING THE BELL THEOREM

Tim Palmer



The Penrose “Impossible” Triangle appears incomprehensible because we implicitly assume that any two arms become close near a common vertex. It is made comprehensible by relaxing this assumption i.e. by analysing in a more appropriate 3D metric. Analogously, it is shown that the Bell Theorem in quantum physics can be made comprehensible – that is to say, consistent with local realism – if the conventional Euclidean metric of state space is replaced by a more appropriate p-adic-like metric, reflecting some underpinning fractal state-space geometry. In this representation, the Bell Inequality is distant from all forms of the inequality that have been shown to be violated experimentally. Which is to say that the Bell Inequality has not be shown to be violated experimentally, even approximately! This result has implications for finding a locally causal version of the explicitly realistic Bohmian Theory. In this interpretation, the Bohmian quantum potential should be considered a coarse-grain representation of the underpinning fractal state-space geometry.

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Profile

TIM PALMER

Department of Physics, University of Oxford

Tim Palmer is an internationally renowned meteorologist with a particular interest in the predictability and dynamics of the weather and climate.

Tim's work has led to the development of probabilistic techniques to forecast weather and climate, and he has applied this to disease and crop yield prediction and more. His techniques have been implemented by the Met Office and the European Centre for Medium-Range Weather Forecasts, amongst others. Tim's work is theoretical as well as practical. His recent research exploits ideas in imprecise computing to develop computer simulations of weather and climate at very high resolution. His opinion is highly regarded at an international level through serving on multiple government advisory committees and contributing to all reports conducted by the Intergovernmental Panel on Climate Change.

He was appointed as CBE in the 2015 New Year's Honours list for services to science. Tim has won numerous awards from organisations such as the American Meteorological Society and the Institute of Physics. Remarkably, he also retains an active interest in his original doctorate topic, fundamental physics.

(source: The Royal Society)

VIDEOS WITH TIM PALMER

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PHYSICS

Does Bohmian Theory Have to Be Nonlocal? New Directions for Analysing the Bell...

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Ward Struyve

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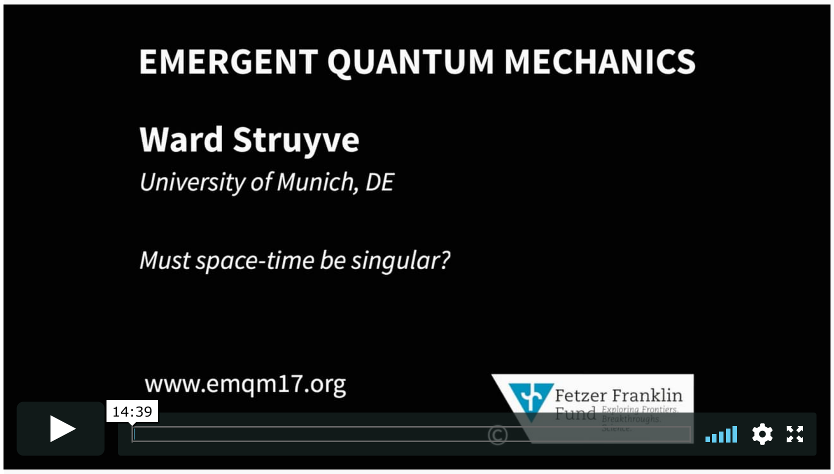
MUST SPACE-TIME BE SINGULAR?

Ward Struyve



According to Einstein's theory of general relativity space-time singularities such as a big bang typically occur. It is believed that a quantum theory for gravity may eliminate such singularities. Whether this is indeed the case may of course depend on which approach to quantum gravity, for example the Wheeler-DeWitt theory or loop quantum gravity. But it may also depend on the approach to quantum mechanics itself, for example the standard quantum approach, consistent histories or Bohmian mechanics. For the case of mini-superspace models, it has been claimed in the context of standard quantum theory that the Wheeler-DeWitt theory does not eliminate the singularities, while loop quantum gravity does. However, the analysis is plagued by a number of conceptual problems: the measurement problem, the problem of time and the problem of what exactly it means to have a singularity. In my talk, I will explain the Bohmian approach to the Wheeler-DeWitt theory and loop quantum gravity and how this approach solves these conceptual problems. I will show for mini-superspace models that in the Wheeler-DeWitt theory the answer to the question of singularities depends on the wave function and the initial metric, and that in loop quantum gravity there are no singularities.

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Participation

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2012-2014: Postdoctoral Fellow, Rutgers University, Piscataway NJ, USA

2008-2012: Postdoctoral Fellow, K.U.Leuven, Leuven, Belgium

2004-2008: Postdoctoral Fellow, Perimeter Insitute, Waterloo, Canada

Education

2000 - 2004: Ph.D. in Physics, Ghent University, Ghent, Belgium

1998 - 2000: M.Sc. in Mathematics, Ghent University, Ghent, Belgium

1996 - 1998: B.Sc. in Mathematics, Ghent University, Ghent, Belgium

(source: Quandrops)

VIDEOS WITH WARD STRUYVE

VIDEO

PHYSICS

Must space-time be singular?

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Profile

WILLIAM SEAGER

Department of Philosophy, University of Toronto at Scarborough

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William Edward Seager (born April 11, 1952 in Edmonton, Alberta) is a Canadian philosopher. He is a Professor of philosophy at the University of Toronto, Scarborough. His academic specialties of the philosophy of mind, and the philosophy of science.

He received his B.A. in 1973 from the University of Alberta. his M.A. in 1976 from the same university and his Ph.D in 1981 from the University of Toronto under the direction of R. B. DeSousa with a thesis on "Materialism and the Foundations of Representation" He has been Associate Editor of Canadian Journal of Philosophy from 2003 – present.

(source: Wikipedia)

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Profile

YAKIR AHARONOV

Institute for Quantum Studies and Schmid College of Science and Technology, Chapman University & School of Physics and Astronomy, Tel Aviv University

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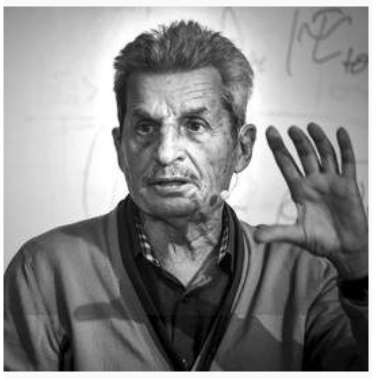
EmQM15 - Emergent Quantum Mechanics



Yakir Aharonov, Ph.D., is professor of theoretical physics at Chapman University, where he holds the James J. Farley Professorship in Natural Philosophy. Considered one of the most highly regarded scientists in the world, Dr. Aharonov received the prestigious Wolf Prize in 1998 for his co-discovery of the Aharonov-Bohm Effect, one of the cornerstones of modern physics.

Born on August 28, 1932, Dr. Aharonov received his undergraduate education at the Technion, graduating with a B.Sc. in 1956. He continued his graduate studies at the Technion and then moved to Bristol University in England, together with his doctoral advisor David Bohm. He received his Ph.D. there in 1960.

Prior to coming to Chapman University in 2008, Dr. Aharonov served on the faculties of Brandeis University, Yeshiva University, Tel Aviv University, the University of South Carolina and George Mason University. He holds the title of emeritus professor from Tel Aviv University. Although Chapman University -- where he conducts research, teaches and lectures to undergraduate and graduate students in the Schmid College of Science and Technology – is his sole full-time affiliation, he also serves as distinguished professor with the Perimeter Institute in Ontario, Canada, a research think-tank where he meets and works with an international roster of renowned fellow members such as Stephen Hawking , Leonard Susskind and Juan Ignacio Cirac, among many others.

Dr. Aharonov's current research with Chapman University team members Menas Kafatos, Ph.D., Jeff Tollaksen, Ph.D. and participants from other universities includes a grant awarded from the Science and Transcendence Advanced Research Series (STAR) for a project titled "Subjective Experience as a Window on Foundational Physics." The aim of the project is to investigate the areas of tension between objective scientific description and human conscious experience.

(source: Chapman University)

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TIME SYMMETRIC REFORMULATION OF QUANTUM MECHANICS

Yakir Aharonov Vienna University of Technology

I will begin my talk with a brief review of Weak Measurements and Weak Values. I will then discuss some recent developments in this field, and, in particular, the discovery that the classical limit of rare pre- and post-selected quantum systems has very novel and exciting properties. I will conclude the talk by discussing a straight forward generalization of Quantum Mechanics that solves the measurement problem and thus gets rid of the many-world interpretation of Quantum Mechanics.

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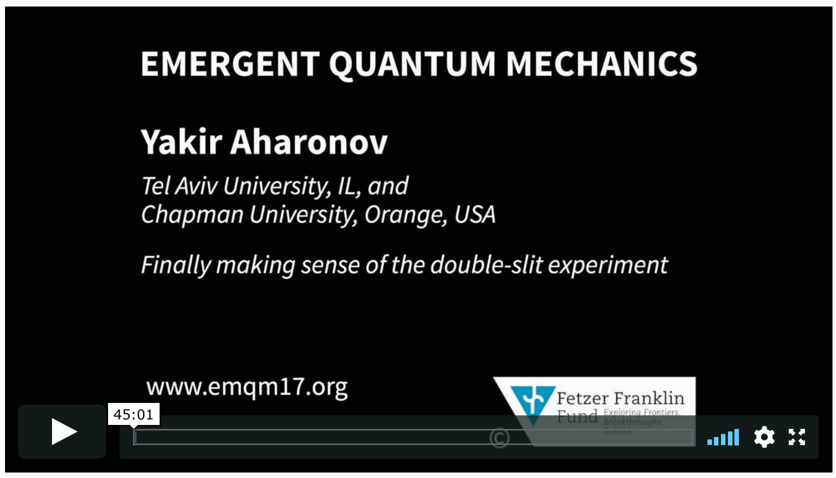
FINALLY MAKING SENSE OF THE DOUBLE-SLIT EXPERIMENT

Yakir Aharonov



Feynman stated that the double-slit experiment ". . . has in it the heart of quantum mechanics. In reality, it contains the only mystery" and that "nobody can give you a deeper explanation of this phenomenon than I have given; that is, [just] a description of it." We rise to the challenge with an alternative to the wave function-centered interpretations: instead of a quantum wave passing through both slits, we have a localized particle with nonlocal interactions with the other slit [Aharonov, Cohen, Colombo, Landsberger, Sabadini, Struppa & Tollaksen (2017) Proc. Natl. Acad. Sci. 114 (25)]. Key to this explanation is dynamical nonlocality, which naturally appears in the Heisenberg picture as nonlocal equations of motion. This insight led us to develop an approach to quantum mechanics which relies on pre- and post-selection, weak measurements, deterministic, and modular variables. This fundamental change in perspective towards a new ontology points to deterministic properties within the Heisenberg picture as being the primitives instead of the wavefunction, which remains an ensemble property.

Using this new approach in a double-slit experiment, we can verify that the particle, which is localized, goes through only one of the slits. In addition to this corpuscular behavior, a nonlocal property originating from the other, distant, slit has been affected through the nonlocal Heisenberg equations of motion.

Although the Heisenberg and Schrödinger pictures are equivalent formulations, nevertheless, the framework presented here has led to new insights, intuitions, and experiments that were missed from the old perspective. For example, this new perspective affects the axiomatic structure of quantum mechanics: under the assumption of nonlocality, uncertainty turns out to be crucial to preserve causality. Hence, a (qualitative) uncertainty principle can be derived rather than assumed.

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FOMENTING (RIGOROUS) TECHNOLOGICAL REVOLUTIONS: REPLICATION AND DARPA'S MISSION

Adam Russell

The mission of the Defense Advanced Research Projects Agency (DARPA) is to invest in „breakthrough technologies and capabilities for national security." Founded in the wake of the Soviet Union's largely unexpected launch of Sputnik in 1957, DARPA's mission has since often been summarized as creating technological surprise, in part to help avoid being surprised by others. Hence, DARPA explicitly reaches for transformational change instead of incremental advances. Given this background, the role of replication in DARPA's mission might appear obvious, but replication's impact on, and value for, high-risk, high-payoff research can vary significantly and is not always self-evident nor straightforward. In this talk, I will offer some observations on replication's role in, and importance for, DARPA's mission, based on my experience serving as a DARPA Program Manager in the Defense Sciences Office and as the "DARPAnthropologist."

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ADAM RUSSELL

DARPA

Adam Russell joined DARPA as a program manager in July 2015. He is interested in new experimental platforms and tools to facilitate discovery, quantification, and “big validation” of fundamental measures in social science, behavioral science, and human performance. Russell has broad technical and management experience across a number of disciplines, ranging from cognitive neuroscience and physiology to cultural psychology and social anthropology. Before joining DARPA, he was a program manager at the Intelligence Advanced Research Projects Activity, where he developed and managed a number of high-risk, high-payoff research projects for the Office of the Director of National Intelligence.

Prior to IARPA, Russell was in the industry, where he was a senior scientist and principal investigator on a wide range of human performance and social science research projects and strategic assessments for a number of different government organizations. Russell holds a Bachelor of Arts in Cultural Anthropology from Duke University and an M.Phil. and a D.Phil. in Social Anthropology from Oxford University, where he was a Rhodes Scholar.

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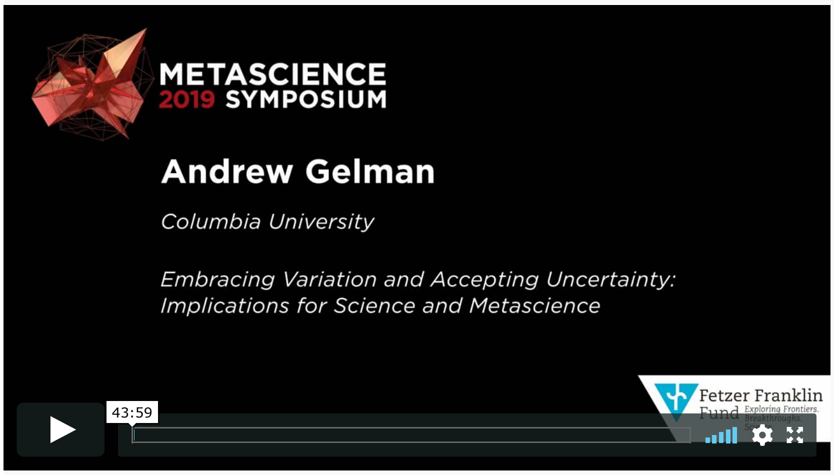
EMBRACING VARIATION AND ACCEPTING UNCERTAINTY: IMPLICATIONS FOR SCIENCE AND METASCIENCE

Andrew Gelman



The world would be pretty horrible if your attitude on immigration could be affected by a subliminal smiley face, if elections were swung by shark attacks and college football games, if how you vote depended on the day within your monthly cycle, etc. Fortunately, there is no good evidence for these and other high-profile claims about the effects of apparently irrelevant stimuli on social and political attitudes and behaviors.

Indeed, for theoretical reasons, we argue that it is not possible for these large and persistent effects to co-exist in the real world. But if the sorts of effects being studied vary greatly by person and scenario, then simple experiments will not yield reliable estimates of effect sizes. It is necessary to instead embrace variation, which, in turn, requires accepting uncertainty. This has implications for the practice of science and for the proper understanding of replication and other aspects of metascience.

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ANDREW GELMAN

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Andrew Gelman is a professor of statistics and political science at Columbia University.

He has published research articles on statistical theory, methods, and computation, with applications in social science and public health. He and his colleagues have written several books, including Bayesian Data Analysis, Teaching Statistics: A Bag of Tricks, Regression and Other Stories, A Quantitative Tour of the Social Sciences, and Red State, Blue State, Rich State, Poor State: Why Americans Vote the Way They Do.

His ideas on metascience include type M and type S errors, the folk theorem of statistical computing, the freshman fallacy, the time-reversal heuristic, the Armstrong principle, the Javert paradox, Eureka bias, Clarke's law, the piranha problem, and the garden of forking paths.

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IS REPLICATION RESEARCH THE STUDY OF RESEARCH OR OF RESEARCHERS?

Annette Brown

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A few years ago, I and my colleagues designed the push button replication project with the dual objectives of discovering whether development impact evaluations are push button replicable and of implementing the project as transparently as possible. We were disappointed upon journal acceptance to be told that we could not make public our findings for individual studies in our sample because we had not received IRB approval. In this presentation, I will report the results of the push button replication project. I will also discuss a set of ethics considerations I have encountered in funding and conducting replication research. These considerations often underly the replication debates, for example the definitions of successful and failed replications, and hinge on the question of whether replication is the study of research or researchers.

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ANNETTE BROWN

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Annette Brown is the Principal Economist at FHI 360, an international non-profit working to improve the health and well-being of people around the world through research and program implementation. She also serves as Editor-in-Chief, and frequently writes for, FHI 360's R&E Search for Evidence blog. Annette's career in international development has spanned academe, non-profits, and for-profits. For the last decade she has focused on supporting and promoting the use of high-quality evidence for programs and policy. Her current research interests include the role and practice of replication research and the systematic review of evidence across a variety of topics. She has published in numerous social science and public health journals, and recently co-guest-edited a special journal section on replication of development impact evaluations. She received a Ph.D. in Economics from the University of Michigan as a National Science Foundation Fellow and a B.A. (Phi Beta Kappa) from Grinnell College.

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Bernhard Voekl

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BIOLOGICAL VARIATION IS MORE THAN RANDOM NOISE

Bernhard Voekl

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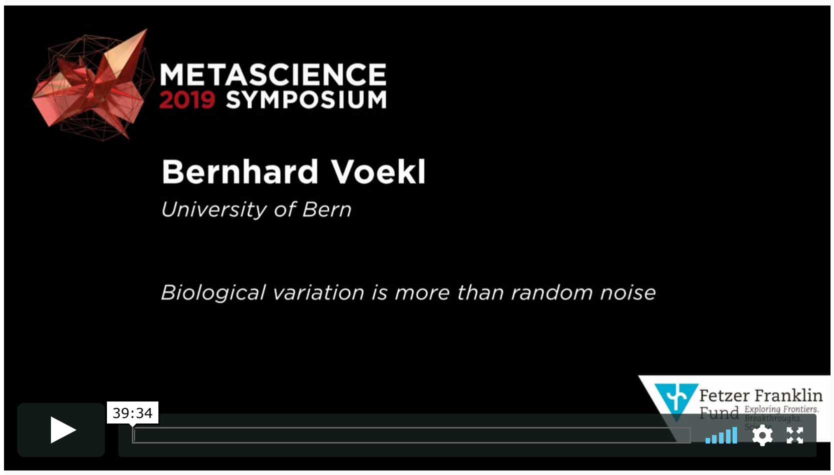

Whenever we are studying living organisms, we are faced with inherent biological variation, which is distinct from random noise or measurement error. Biological variation is the sum of genetic variation, environmentally induced variation, and the interaction of both. That is, the response of an organism to a treatment (e.g. a drug) depends not only on the treatment but also on the state of the organism, which is as much the product of past and present environmental influences as of its genetic architecture. This context-de- pendent responsiveness presents a unique challenge to reproducibility in all areas of biomedical research. Fully acknowledging this, requires adopting a reaction norm perspective on physiological and behavioural responses. The gist of the reaction norm approach is to abandon the idea of a “true” population parameter and it entails a fundamental re-thinking of parameter estimation, statistical inference and interpretation of study results in the life sciences.

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Profile

BERNHARD VOEKL

Animal Welfare Division, University of Bern

Bernhard Voelkl is a postdoctoral researcher at the Veterinary Public Health Institute of the University of Bern, Switzerland. He studied biology and zoology at the University of Vienna receiving his PhD in 2005. He is an evolutionary ecologist who has worked with various study species (primates and birds) both in the field and the lab. The topic of his early research focused on cooperation and social information propagation in animal communities and animal social networks.

He has worked as a postdoctoral researcher at the CNRS-Strasbourg, the Humboldt University at Berlin and the Edward Grey Institute of Field Ornithology at the University of Oxford. He is the scientific coordinator of Waldrappteam and elected fellow of the Royal Geographic Society. Recently he has turned his attention towards the reproducibility of preclinical animal studies and investigates how the norm of reaction affects biological variability and reproducibility of study results in biomedical animal research.

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BRIAN NOSEK

Department of Psychology, University of Virginia, USA

Brian Nosek received a Ph.D. in from Yale University in 2002 and is a professor in the Department of Psychology at the University of Virginia. In 2007, he received early career awards from the International Social Cognition Network (ISCON) and the Society for the Psychological Study of Social Issues (SPSSI). He co-founded Project Implicit an Internet-based multi-university collaboration of research and education about implicit cognition - thoughts and feelings that exist outside of awareness or control. Nosek investigates the gap between values and practices - such as when behavior is influenced by factors other than one's intentions and goals. Research applications of this interest are implicit bias, diversity and inclusion, automaticity, social judgment and decision-making, attitudes, beliefs, ideology, morality, identity, memory, and barriers to innovation. Through lectures, training, and consulting, Nosek applies scientific research to improve the alignment between personal and organizational values and practices. Nosek also co-founded and directs the Center for Open Science that operates the Open Science Framework. The COS aims to increase openness, integrity, and reproducibility of scientific research.

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Profile

CAILIN O'CONNOR

Logic & Philosophy of Science, University of California, Irvine

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Cailin O'Connor is a philosopher of biology and behavioral sciences, philosopher of science, and evolutionary game theorist. She is an Associate Professor in the Department of Logic and Philosophy of Science, and a member of the Institute for Mathematical Behavioral Science at UC Irvine. She is currently administering the NSF grant Social Dynamics and Diversity in Epistemic Communities. Her book The Misinformation Age was published with Yale University Press. It has been covered in the New York Times, on Hidden Brain, and on The Open Mind. Her monograph The Origins of Unfairness will be published with OUP in summer 2019. Cailin is also a sometime science writer. When not busy doing philosophy, she is a poultry enthusiast and aerial acrobat. Her Erdos-Bacon number is 7.

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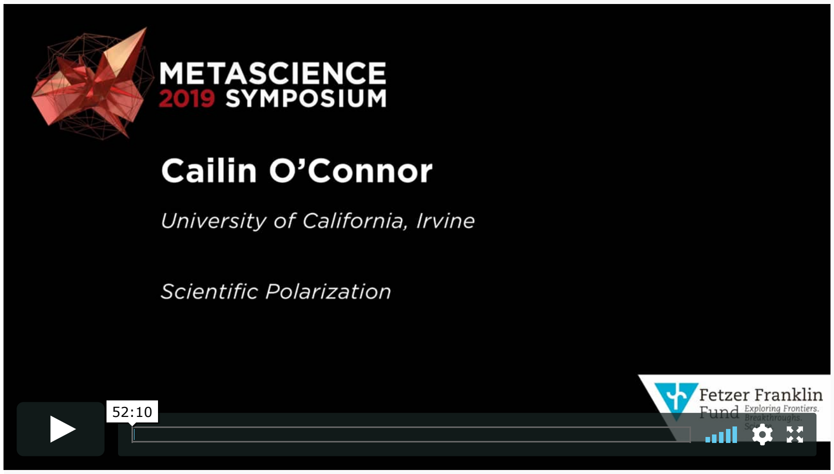

Sometimes scientific communities polarize over matters of fact, even when they share epistemic goals, and have access to the same evidence. In this talk, I discuss why scientists might polarize in this way. Drawing on the motivating case of chronic Lyme disease, I present results from epistemic network models where actors share evidence, seek truth, and nonetheless polarize. This happens when scientists become skeptical of evidence shared by community members whose beliefs diverge too far from their own. This tendency towards mistrust hurts the knowledge-producing capacity of the group in many cases, and can lead to the emergence of epistemic „factions" that share multiple, polarized beliefs. But, as I discuss, it is nonetheless often a reasonable epistemic strategy.

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Profile

CARL T. BERGSTROM

Department of Biology, University of Washington

Carl T. Bergstrom is a Professor in the Department of Biology at the University of Washington. Dr. Bergstrom's research uses mathematical, computational, and statistical models to understand how information flows through biological and social systems. His recent projects include contributions to the game theory of communication and deception, use of information theory to the study of evolution by natural selection, game-theoretic models and empirical work on the sociology of science, and development of mathematical techniques for mapping and comprehending large network datasets. In the applied domain, Dr. Bergstrom's work illustrates the value of evolutionary biology for solving practical problems in medicine and beyond. These problems include dealing with drug resistance, handling the economic externalities associated with anthropogenic evolution, and controlling novel emerging pathogens such as the SARS virus, Ebola virus, and H5N1 avian influenza virus.

He is the coauthor of the college textbook Evolution, published by W. W. Norton and Co., and teaches undergraduate courses on evolutionary biology, evolutionary game theory, and the importance of evolutionary biology to the fields of medicine and public health. Dr. Bergstrom received his Ph.D. in theoretical population genetics from Stanford University in 1998; after a two-year postdoctoral fellowship at Emory University, where he studied the ecology and evolution of infectious diseases, he joined the faculty at the University of Washington in 2001.

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THE INHERENT INEFFICIENCY OF GRANT PROPOSAL COMPETITIONS AND THE POSSIBLE BENEFITS OF LOTTERIES IN ALLOCATING RESEARCH FUNDING

Carl T. Bergstrom

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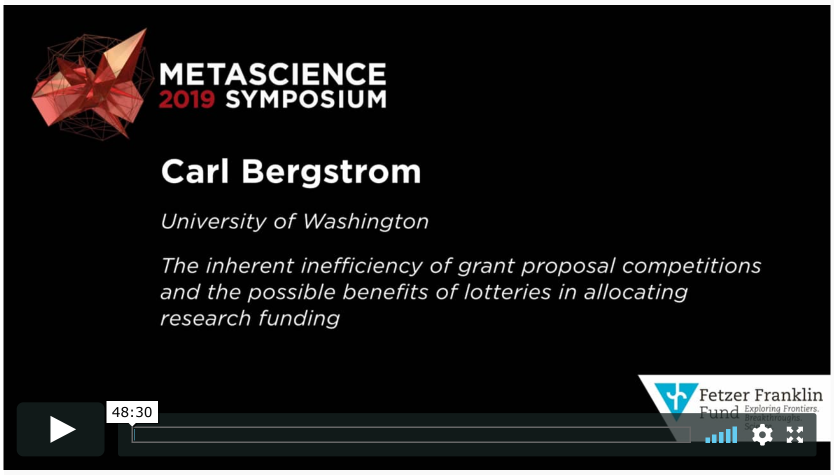

A large fraction of scientific research funding is alloca- ted through a system of grant proposals and awards. We use the economic theory of contests to analyze the economic efficiency of this process. Investigators participate in contests to write high-quality proposals. Funding agencies use these contests not as a mechanism for extracting work from participants, but rather as a screening mechanism intended to reveal the most promising research projects. As a first approximation, the work that investigators do in proposal preparation provides no extrinsic value to the funder. We find that the effort researchers expend in preparing proposals may be comparable to the total scientific value of the additional funding. The problem may be exacerbated as the fraction of funded proposals drops. When investigators derive non-scientific utility from their funding successes (in the forms of e.g., hiring, promotion, tenure, or reputation), the net effect of a funding program on scientific productive can be negative. We suggest that partial lotteries for funding may ameliorate the problem by reducing the intensity of competition and the extra-scientific benefits associated with funding success.

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GENDER-BASED HOMOPHILY IN COLLABORATIONS ACROSS A HETEROGENEOUS SCHOLARLY LANDSCAPE

Carole Lee

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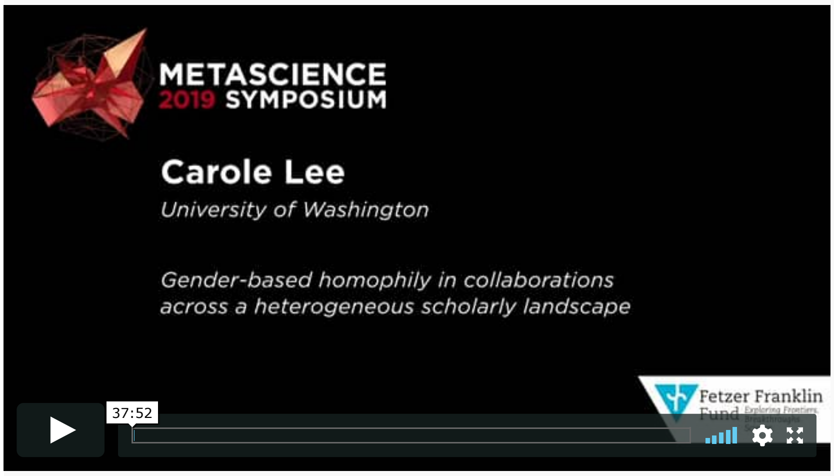

In this talk, I develop a view of science as the social production of collective knowledge by a complex adaptive system. Using data from millions of scientific papers, I illustrate that scientists' research choices are shaped by the tension between tradition and innovation, which generates a distributed algorithm for directing scientists' collective attention. I then show how this distributed algorithm leads to more (and less) efficient collective discovery.

Such distributed algorithms are "programmed" by scientific institutions. To clarify our understanding of these institutions, I describe a simple formal model of scientific problem choice and use it to show that taken-for-granted features of scientific institutions can have unexpected consequences on the pace of knowledge production. I draw together these results using ideas from computational learning theory to suggest how scientists' strategies, though objectively adapted to social goals, can nonetheless support robust collective creation of knowledge about the natural world. In other words, the production of collective knowledge is made possible by the distinctive cultural technologies of science—which also produce limits to that same knowledge.

I conclude by briefly considering the ominous possibility that the participation of (even quite modest) "machine knowers" in science could produce insurmountable limits to human understanding.

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CAROLE LEE

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Carole Lee is an Associate Professor in the Department of Philosophy at the University of Washington. She studies the formal and informal processes of peer evaluation that allocate limited scholarly resources such as co-authorships, publication pages, grant awards, and scientific prizes. She has worked with the National Institutes of Health and the Doris Duke Charitable Foundation to study their grant evaluation processes and published in journals reaching philosophical and broad scientific and biomedical audiences (e.g., Science, The Lancet).

Her research has been supported by the National Science Foundation, the National Institutes of Health, and the Mellon and Woodrow Wilson Foundations (through a Career Enhancement Fellowship). She received First Prize for most creative submission to NIH's Peer Review Challenge (with her collaborator Elena Erosheva).

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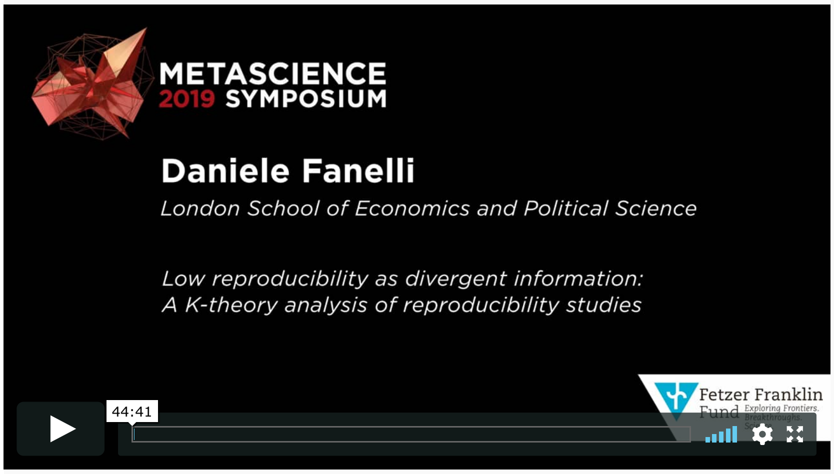
LOW REPRODUCIBILITY AS DIVERGENT INFORMATION: A K-THEORY ANALYSIS OF REPRODUCIBILITY STUDIES

Daniele Fanelli



This talk will illustrate how reproducilbility and replication in science can be studied using and a new theory and methodology called K-theory. Based on a classic and algorithmic information theory, K-theory is a candidate theoretical framework for metascience, which offers elegant mathematical answers to "big" meta-scientific questions including 'how much know- ledge is attained by a research field?', 'how rapidly is a field making progress?', 'what is the expected repro- ducibility of a result?', 'how much knowledge is lost from scientific bias and misconduct?', 'what do we mean by soft science?', and 'what demarcates a pseu- doscience?' (see https://doi.org/10.1098/rsos.181055). We will briefly introduce K-theory, then look at how the theory understands reproducibility and what predictions it makes, and then present results of a "K-analysis" of reproducibility data in psychology.

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DANIELE FANELLI

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Daniele Fanelli is a fellow in Quantitative Methodology at the London School of Economics, UK, where he teaches research methods and investigates the nature of science and possible issues with scientific evidence. He graduated in Natural Sciences, giving exams in all fundamental disciplines, then obtained a PhD studying the behaviour and genetics of social wasps, and subsequently worked for two years as a science writer. All of his postdoctoral work has been devoted to studying the nature of science itself, and the mis-behaviours of scientists. His empirical research has been instrumental in quantifying the prevalence and causes of problems that may affect research across the natural and social sciences, and it has helped develop remedies and preventive measures.

In addition to his scientific work, Daniele co-chairs the Research Integrity Sub-Committee within the Research Ethics and Bioethics Advisory Committee of Italy's National Research Council, for which he developed the first research integrity guidelines. He is also a member of the Research Integrity Committee of the Luxembourg Agency for Research Integrity (LARI), was formerly a member of Canada's Tri-Council Expert Panel on Research integrity, and is currently rapporteur for a European Mutual Learning Exercise on Research Integrity.

Before joining the London School of Economics, Daniele worked at the University of Edinburgh, UK, at the University of Montreal, CA, and at Stanford University, USA, in the Meta-Research Innovation Center @ Stanford (METRICS).

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DEAN KEITH SIMONTON

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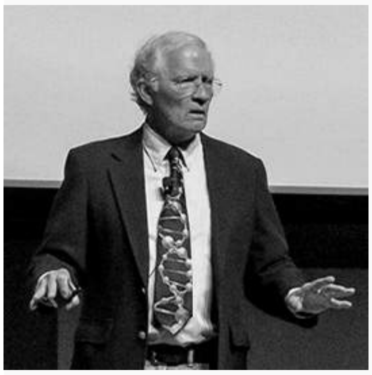

Dean Keith Simonton is Distinguished Professor Emeritus of Psychology at the University of California, Davis. After earning his 1975 Harvard doctorate in social psychology, his research has largely focused on diverse aspects of genius, creativity, leadership, talent, and aesthetics. Although he most frequently uses historiometric methods, he has also published mathematical models, computer simulations, laboratory experiments, psychometric assessments, meta-analyses, interviews, and single-case studies. The resulting output includes 14 books, 153 book chapters, 47 entries in 27 encyclopedias, and 345 contributions to 134 journals, annuals, and other periodicals. His Google i10- and h-indices stand at 259 and 75, respectively.

Dr. Simonton has also received numerous honors, such as the William James Book Award, the George A. Miller Outstanding Article Award, the SPSP Theoretical Innovation Prize, and the Sir Francis Galton Award. In 2018 MIT Press put out The Genius Checklist: Nine Paradoxical Tips on How You Can Become a Creative Genius.

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SCIENTIFIC CREATIVITY: DISCOVERY AND INVENTION AS COMBINATORIAL

Dean Keith Simonton

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Although scientific creativity is often viewed as entailing some combinatorial process or procedure, it is necessary to more explicitly formalize what that actually means. By focusing on creativity as problem solving, three parameters are used to describe eight possible combinatorial solutions, only one of which is considered creative. The latter leads to a three-critertion creativity definition, namely, that personally assessed creativity is a multiplicative function of originality, utility, and surprise.
This definition then has six major implications, implications that are partly illustrated using Monte Carlo simulations. One key repercussion is that creativity always requires some involvement of trial and error, generate and test, or blind variation and selective retention (however named). Moreover, the formal representation implies that no single pro- cess or procedure can ever be specified as generating the creative combinatorial solutions. The presentation concludes by using the three-criterion definition to indicate how creativity differs in the arts and sciences.

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Dorothy Bishop is a psychologist who holds a Wellcome Trust Principal Research Fellowship at the Department of Experimental Psychology, University of Oxford, where she heads an ERC-funded programme of research into cerebral lateralisation for language. She is a supernumerary fellow of St John's College Oxford, a Fellow of the Royal Society, Fellow of the British Academy and Fellow of the Academy of Medical Sciences. Her main research interests are in the nature and causes of developmental language difficulties, with a particular focus on psycholinguistics, neurobiology and genetics. In 2015 Dorothy chaired a symposium on Reproducibility in Biomedical Science organised by the Academy of Medical Sciences, Wellcome Trust, MRC, and BBSRC, and she is chairing the advisory board of the recently-formed UK Reproducibility Network. She has a popular blog, Bishopblog, which features posts on a wide range of topics, including those relevant to reproducibility.

VIDEOS WITH DOROTHY BISHOP

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The psychology of scientists: The role of cognitive biases in sustaining bad science

PAPERS FROM DOROTHY BISHOP

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THE PSYCHOLOGY OF SCIENTISTS: THE ROLE OF COGNITIVE BIASES IN SUSTAINING BAD SCIENCE

Dorothy Bishop

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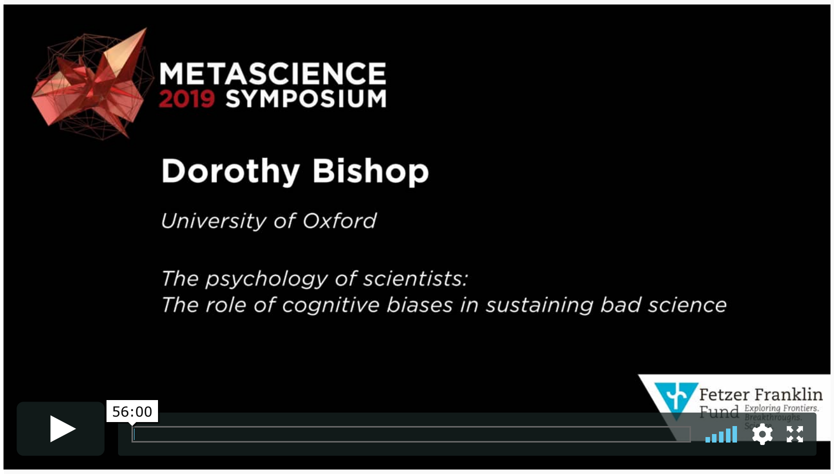

Much has been written about how we might tackle the so-called "replication crisis". There have been two lines of attack. First, there are those who emphasise the need for better training in experimental design and statistics. Second, it is recognised that we need a radical overhaul of the incentive structure of science. I shall argue, however, that to improve scientific practices we need to go deeper, to understand and counteract the mechanisms that maintain bad practices – not just at the institutional level, but in individual people. Misunderstanding of statistics, and the incentive structure that has evolved, have their roots in human cognition. I shall discuss how scientific thinking is not natural for humans: biased attention in conditions of information overload, use of cognitive schemata, and asymmetric moral reasoning all play a part in sustaining maladaptive scientific practices.

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INNOVATIONS IN PRE-REGISTRATION IN ECONOMICS

Edward Miguel

The adoption of pre-registration has increased rapidly in Economics since the start of the American Economic Association registry in 2013. We discuss recent evidence on the practice of pre-registration in Economics, including opportunities for improvement. We survey frontier topics in pre-registration in the field, including the collection of expert forecasts, pre-specifying the research process, the pre-registration of prospective observational studies, and recent journal efforts to incorporate pre-results review.

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EDWARD MIGUEL

University of California at Berkeley

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He earned S.B. degrees in both Economics and Mathematics from MIT, received a Ph.D. in Economics from Harvard University, where he was a National Science Foundation Fellow, and has been a visiting professor at Princeton University and Stanford University.

Ted's main research focus is African economic development, including work on the economic causes and consequences of violence; the impact of ethnic divisions on local collective action; interactions between health, education, environment, and productivity for the poor; and methods for transparency in social science research. He has conducted field work in Kenya, Sierra Leone, Tanzania, and India. He has published over 80 articles and chapters in leading academic journals and collected volumes, and his work has been cited over 20,000 times according to Google Scholar.

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MISINTERPRETATIONS OF EVIDENCE, AND WORSE MISINTERPRETATIONS OF EVIDENCE

Fiona Fidler

P-values are frequently misinterpreted. Confidence intervals are too. So are Bayesian statistics. Sometimes this simple equivalence is used as an argument that statistical cognition shouldn't play a role in deciding which analysis approach to adopt in practice, or to teach to students. But are misinterpretations of these different displays of statistical evidence equally severe?

Do they have the same consequences in practice? In this talk I'll present the limited empirical evidence related to these questions that we have so far, and suggest that, at the very least, we don't know enough to assume Abelson's law yet, i.e., "Under the law of the diffusion of idiocy, every foolish application of signifi- cance testing is sooner or later going to be translated into a corresponding foolish practice for confidence limits" (Abelson, 1997, p. 130). There may be other sound reasons - technical or philosophical reasons—to reject one approach or another, but we shouldn't (yet) consider them cognitively equivalent.

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Profile

FIONA FIDLER

University of Melbourne

Fiona Fidler is Associate Professor at the University of Melbourne, with a joint appointment in the Schools of BioSciences and History and Philosophy of Science. She is broadly interested in how experts, including scientists, make decisions and change their minds. Her past research has examined how methodological change occurs in different disciplines, including psychology, medicine and ecology, and developed methods for eliciting reliable expert judgements to improve decision making. She originally trained as a psychologist, and maintains a strong interest in psychological methods. She also has an abiding interest is statistical controversies, for example, the ongoing debate over Null Hypothesis Significance Testing. She is a current Australian Research Council Future Fellow, and leads the University of Melbourne's Interdisciplinary MetaResearch Group (IMeRG).

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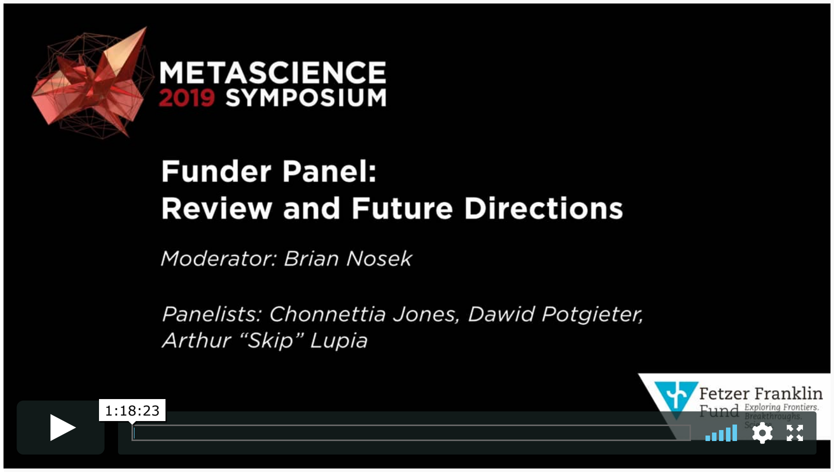

Moderator:

Brian Nosek (Center for Open Science, USA)

Panelists:

Chonnettia Jones (Wellcome Trust, UK)

Dawid Potgieter (Templeton World Charity Foundation, BHS)

Arthur "Skip" Lupia (National Science Foundation, USA)

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SPEAKER
Jacob Foster

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MADE TO KNOW: SCIENCE AS THE SOCIAL PRODUCTION OF KNOWLEDGE (AND ITS LIMITS)

Jacob Foster

In this talk, I develop a view of science as the social production of collective knowledge by a complex adaptive system. Using data from millions of scientific papers, I illustrate that scientists' research choices are shaped by the tension between tradition and innovation, which generates a distributed algorithm for directing scientists' collective attention. I then show how this distributed algorithm leads to more (and less) efficient collective discovery.

Such distributed algorithms are "programmed" by scientific institutions. To clarify our understanding of these institutions, I describe a simple formal model of scientific problem choice and use it to show that taken-for-granted features of scientific institutions can have unexpected consequences on the pace of knowledge production. I draw together these results using ideas from computational learning theory to suggest how scientists' strategies, though objectively adapted to social goals, can nonetheless support robust collective creation of knowledge about the natural world. In other words, the production of collective knowledge is made possible by the distinctive cultural technologies of science—which also produce limits to that same knowledge.

I conclude by briefly considering the ominous possibility that the participation of (even quite modest) "machine knowers" in science could produce insurmountable limits to human understanding.

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Profile

JACOB FOSTER

UCLA

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My empirical work focuses on computational approaches to the sociology of science. I blend network analysis, complex systems thinking, and data-driven probabilistic modeling with the qualitative insights of the science studies literature to probe the strategies, dispositions, and social processes that shape the production and persistence of scientific ideas. I also develop formal models of scientific behavior and the evolutionary dynamics of ideas and institutions. Fundamentally, I aim to understand the social world as constituted by, and constitutive of, ideas, beliefs, and practices. Science provides an excellent "model organism" for this endeavor. My approach is strongly informed by research on complex systems and biological and cultural evolution.

VIDEOS WITH JACOB FOSTER

VIDEO

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Made to Know: Science as the Social Production of Knowledge (and its Limits)

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JAMES EVANS

University of Chicago

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James Evans' research uses large-scale data, machine learning and generative models to understand how collectives think and what they know. This involves inquiry into the emergence of ideas, shared patterns of reasoning, and processes of attention, communication, agreement, and certainty. Thinking and knowing collectives like science, Wikipedia or the Web involve complex networks of diverse human and machine intelligences, collaborating and competing to achieve overlapping aims. Evans' work connects the interaction of these agents with the knowledge they produce and its value for themselves and the system. Evans designs observatories for understanding that fuse data from text, images and other sensors with results from interactive crowd sourcing and online experiments. Much of Evans' work has investigated modern science and technology to identify collective biases, generate new leads taking these into account, and imagine alternative discovery regimes. He has identified R&D institutions that generate more and less novelty, precision, density and robustness. Evans also explores thinking and knowing in other domains ranging from political ideology to popular culture. His work has been published in Nature, Science, PNAS, American Journal of Sociology, American Sociological Review, Social Studies of Science, and many other journals.

VIDEOS WITH JAMES EVANS

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The social limits of scientific certainty

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THE SOCIAL LIMITS OF SCIENTIFIC CERTAINTY

James Evans

This talk will explore how social connection between scientists places soft but strong limits on what science can know and discover. This includes empirical demonstrations of how centralized networks of scientists decrease the truth value of collective certainty, how large teams shrink the search space of science, and how scientist flocking correlates investigations, slows discovery and limits the size of future understanding. I then explore the importance of research patterns and science policies that maintain productive disconnection between disciplines and networks to accelerate advance by increasing the value of ensembling and ultimate recombination.

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COUNTERFACTUAL META-EXPERIMENTATION AND THE LIMITS OF SCIENCE: 100 YEARS OF PARAPSYCHOLOGY AS A CONTROL GROUP

Jan Walleczek

Are the limits of science, the limits of scientific reproducibility? In probing the meta-scientific question concerning the practical versus the fundamental limits of the scientific method, one may consider the large data base from 100 years of parapsychology.

Under the skeptical assumption that anomalous (psi) phenomena do not exist in controlled laboratory experiments, parapsychology as-a-whole represents a control group for assessing the practical limits of the scientific process. How to empirically distinguish between true-positive and false-positive effects in anomalies research? To address this question, the advanced meta- experimental protocol (AMP) was developed, which includes the concept of the sham-experiment, i.e., counterfactual meta-experimentation. As a first test case, the AMP was adopted in a large-scale, confirmatory replication attempt (10,000 test trials) of a widely- publicized parapsychological study, known as the Radin double-slit experiment on psycho-kinetic consciousness. The AMP revealed a false-positive effect upon determining the true-negative detection rate of the methodology used in the Radin experiment.

For the movement that seeks to reform the research process, counterfactual meta-experimentation provides a powerful tool for revealing the (possible) presence of false-positive effects in any experimental paradigm, including in parapsychology and anomalies research in general.

Reference: Walleczek, J. and von Stillfried, N. (2019) False-positive effect in the Radin double-slit experiment on observer consciousness as determined with the advanced meta-experimental protocol (AMP). Front. Psychol., doi: 10.3389/fpsyg.2019.01891.

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[Metascience 2019 Symposium - The Emerging Field of Research on the Scientific Process]

[EmQM17 - Towards Ontology of Quantum Mechanics and the Conscious Agent]

[EmQM15 - Emergent Quantum Mechanics]

[EmQM13 - Emergent Quantum Mechanics]

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Profile

JAN WALLECZEK

Phenoscience Laboratories

Jan Walleczek Ph.D. is Director of the Fetzer Franklin Fund, and a Trustee of the John E. Fetzer Memorial Trust. He lives in Berlin, Germany, where he founded Phenoscience Laboratories. Previously he was Director of the Bioelectromagnetics Laboratory at Stanford University Medical School, Palo Alto, California. Jan Walleczek studied biology at the University of Innsbruck in Austria, followed by doctoral work at the Max-Planck-Institute for Molecular Genetics in Berlin, and post-doctoral work at the Research Medicine and Radiation Biophysics Division of the Lawrence Berkeley National Laboratory, University of California at Berkeley.

His research interests are diverse, and his scientific publications cover the fields of biology, chemistry, engineering, and physics. His work focuses on the foundations of quantum mechanics and the application to living systems of concepts such as quantum coherence, emergent dynamics, and the flow of information, a long-standing interest that he summarized as an edited volume for Cambridge University press titled "Self-organized biological dynamics and nonlinear control". In addition to metascience and advanced research design, his professional interests include the philosophy and the foundations of science.

VIDEOS WITH JAN WALLECZEK

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Paper
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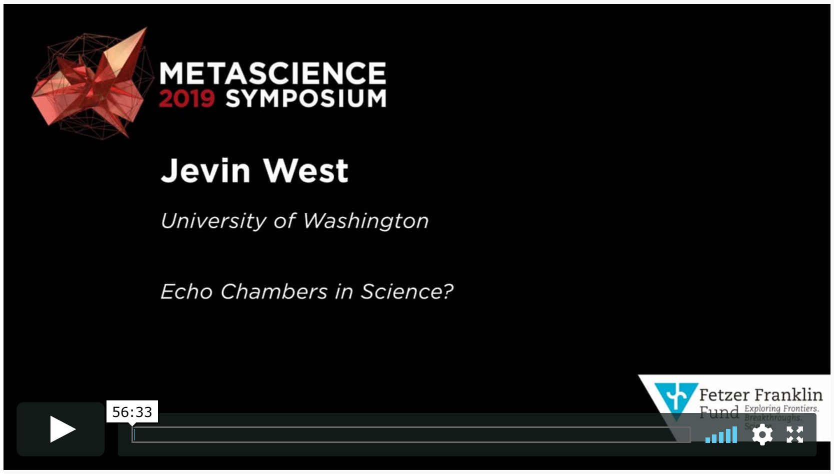
ECHO CHAMBERS IN SCIENCE?

Jevin West



Digitization of the scientific literature has been trans- formative. Researchers now instantaneously access millions of papers—unquestionably a good thing for science. However, this access generally filters through search engines, library portals, and recommender systems. Here, it is less clear whether, and in what ways, these filters are benefiting scientific discovery. How are these technological lenses changing the practice of scientific discovery and information dissemination? Are these tools increasing access to a broader range of the literature and thereby democratizing science? Or are scientists reading a more concentrated set of papers and as a result creating a kind of filter bubble? In this talk, I will provide a set of studies that examine the extent of citation and usage-based concentration across the digital transition and the changing role of journals in article-based search environments.

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Profile

JEVIN WEST

University of Washington

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Jevin West is an Assistant Professor in the Information School at the University of Washington and co-founder of the DataLab. He is an Adjunct Faculty member in the Paul G. Allen School of Computer Science & Engineering, Data Science Fellow at the eScience Institute and Affiliate Faculty in the Center for Statistics & Social Sciences at UW. He develops knowledge discovery tools to study and facilitate science. His methods aim to detect the origins of scientific disciplines, the social and economic biases that drive these disciplines, and the impact the current publication system has on the health of science. This work led to a new course on Calling BS that he and his colleague, Carl Bergstrom, developed to combat misinformation that comes wrapped in data, figures, visualizations and statistics. The course is now being taught at universities around the globe.

VIDEOS WITH JEVIN WEST

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Echo Chambers in Science?

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HOW REPLICABLE CAN PSYCHOLOGICAL SCIENCE BE?: A HIGHLY POWERED MULTI-SITE INVESTIGATION OF THE ROBUSTNESS OF NEWLY DISCOVERED FINDINGS

Jonathan Schooler

There has been an increasing concern among scientists regarding irreproducibility of scientific findings in general, and psychological findings in particular. To date, the understanding of reproducibility has been impeded by two related challenges: 1) the lack of transparency of the scientific record, and 2) the retrospective nature of reproducibility studies. In order to overcome these obstacles, four labs conducted a large scale multi-site prospective multi-replication study. Each lab independently discovered new psychological findings that were then systematically replicated by the originating laboratory and by the others, following a complex pre-specified sequence of various replications and analyses. In so doing, this project 1) developed a gold standard for replication protocol, in which every effort was made to design experiments and implement replications in a manner that simultaneously maintained ecological validity while maximizing the likelihood of full replicability, and 2) tested whether the replications of newly devised experimental protocols are associated with declining effect sizes, even when all reasonable efforts are made to minimize such declines. Although the project is still underway, preliminary analyses indicate that when a gold standard approach is applied psychological findings are highly robust.

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Profile

JONATHAN SCHOOLER

Department of Psychological & Brain Sciences, University of California, Santa Barbara, USA

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Jonathan Schooler Ph.D. is a Professor of Psychological and Brain Sciences at the University of California Santa Barbara (UCSB). His research on human cognition explores topics that intersect philosophy and psychology, such as how fluctuations in people's awareness of their experience mediate mind-wandering and how exposing individuals to philosophical positions alters their behavior.

He is also interested in the science of science (meta-science) including understanding why effects sizes often decline over time, and how greater transparency in scientific reporting might address this issue. Towards this end, he co-organized, with support from the Fetzer Franklin Fund, a major interdisciplinary meeting on the decline effect at UCSB in 2012. A former holder of a Tier 1 Canada Research Chair, he is a fellow of a variety of scientific organizations, on the editorial board of a number of psychology journals, and the recipient of major grants from both the United States and Canadian governments as well as several private foundations. His research and comments are frequently featured in major media outlets such as *The New York Times, The New Yorker, and Nature Magazine.*

VIDEOS WITH JONATHAN SCHOOLER

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Marta Sales Pardo

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COLLABORATION PATTERNS IN SCIENCE

Marta Sales Pardo

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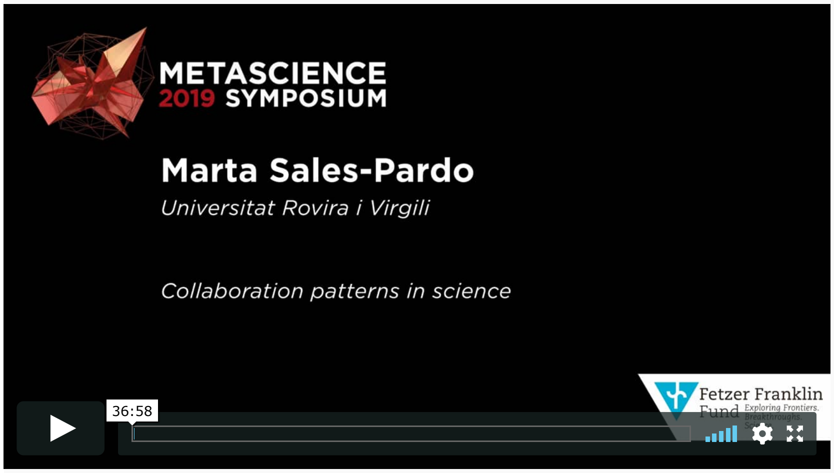

A number of studies have shown that engaging in scientific teams has the potential of boosting the impact of the research results independently of the field.
However, the way scientists engage in such collaborations is affected by many factors including gender and funding. In this talk I will discuss how these two factors affect collaboration patterns using results derived form two studies: a gender study of scientists in top US universities in different fields of science and a study of top-performing scientists across continents and scientific fields.

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Profile

MARTA SALES PARDO

Universitat Rovira i Virgili

Marta Sales-Pardo graduated in Physics at Universitat de Barcelona in 1998 and obtained a Ph.D. in Physics from Universitat de Barcelona in 2002. She then moved to Northwestern University, where she first worked as a postdoctoral fellow and, later, as a Fulbright Scholar. In 2008, she became a Research Assistant Professor at the Northwestern University Clinical and Translational Science Institute with joint appointments in the Department of Chemical and Biological Engineering and the Northwestern Institute on Complex Systems. In 2009, she accepted her current position as in the Departament d'Enginyeria Química at Universitat Rovira i Virgili. In 2013 she received an ICREA Acadèmia Award for excellence in research.

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Profile

MELISSA SCHILLING

New York University

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Melissa A. Schilling is the Herzog Family Professor of Management at New York University Stern School of Business. She received her Bachelor of Science in business administration from the University of Colorado at Boulder. She received her Doctor of Philosophy in strategic management from the University of Washington. Professor Schilling's research focuses on innovation and strategy in high technology industries such as smartphones, video games, pharmaceuticals, biotechnology, electric vehicles, and renewable energies. She is particularly interested in platform dynamics, networks, creativity, and breakthrough innovation. Her textbook, Strategic Management of Technological Innovation (now in its fifth edition), is the number one innovation strategy text in the world. She is also coauthor of Strategic Management: An integrated approach (now in its twelfth edition).

VIDEOS WITH MELISSA SCHILLING

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Where do breakthrough ideas come from?

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WHERE DO BREAKTHROUGH IDEAS COME FROM?

Melissa Schilling

Most innovations and scientific discoveries are incremental advances of existing knowledge and technology. Some innovations and discoveries, however, appear to be much larger leaps, and can be very disconnected from, or disruptive to, existing technology trajectories and scientific theories and paradigms. Where do such breakthrough ideas come from, and is there any way to foster their discovery? This presentation will integrate results from two studies: A seven-year multiple case study research project on serial breakthrough innovators, and a large sample analysis of "outlier patents." These studies reveal common patterns - including innovator characteristics, experiences, and search processes — underlying the generation and pursuit of breakthrough ideas.

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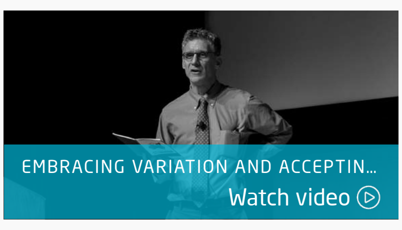
METASCIENCE 2019 SYMPOSIUM – THE EMERGING FIELD OF RESEARCH ON THE SCIENTIFIC PROCESS

05/09 – 08/09/2019, Stanford University, Cubberley Auditorium

Videos Speakers Event-Info

During this decade, we have witnessed the emergence of a new discipline called metascience, metaresearch, or the science of science. Most exciting is the fact that this is emerging as a truly interdisciplinary enterprise with contributors from every domain of research. This symposium serves as a formative meeting for metascience as a discipline. The meeting will bring together leading scholars that are investigating questions related to themes.

VIDEOS



- **CARL T. BERGSTROM:** *The inherent inefficiency of grant proposal competitions and the possible benefits of lotteries in allocating research funding*
- **DOROTHY BISHOP:** *The psychology of scientists: The role of cognitive biases in sustaining bad science*
- **ANNETTE BROWN:** *Is replication research the study of research or of researchers?*
- **TIM ERRINGTON:** *Barriers to conducting replications – challenges or opportunities?*
- **JAMES EVANS:** *The social limits of scientific certainty*
- **DANIELE FANELLI:** *Low reproducibility as divergent information: A K-theory analysis of reproducibility studies*
- **FIONA FIDLER:** *Misinterpretations of evidence, and worse misinterpretations of evidence*
- **JACOB FOSTER:** *Made to Know: Science as the Social Production of Knowledge (and its Limits)*
- **ANDREW GELMAN:** *Embracing Variation and Accepting Uncertainty: Implications for Science and Metascience*
- **STEVEN GOODMAN:** *Statistical methods as social technologies versus analytic tools: Implications for metascience and research reform*
- **ZOLTÁN KEKECS:** *How to produce credible research on anything*
- **CAROLE LEE:** *Gender-based homophily in collaborations across a heterogeneous scholarly landscape*
- **EDWARD MIGUEL:** *Innovations in Pre-registration in Economics*
- **STAŠA MILOJEVIĆ:** *The Changing Landscape of Knowledge Production*
- **MICHÈLE B. NUIJTEN:** *Checking Robustness in 4 Steps*
- **CAILIN O'CONNOR:** *Scientific Polarization*
- **ADAM RUSSELL:** *Fomenting (Rigorous) Technological Revolutions: Replication and DARPA's Mission*
- **MARTA SALES PARDO:** *Collaboration patterns in science*
- **MELISSA SCHILLING:** *Where do breakthrough ideas come from?*
- **JONATHAN SCHOOLER:** *How replicable can psychological science be?: A highly powered multi-site investigation of the robustness of newly discovered findings*
- **DEAN KEITH SIMONTON:** *Scientific Creativity: Discovery and Invention as Combinatorial*
- **ROBERTA SINATRA:** *Quantifying the evolution of scientific careers*
- **PAULA STEPHAN:** *Practices and Attitudes Regarding Risky Research*
- **SIMINE VAZIRE:** *Towards a More Self-Correcting Science*
- **BERNHARD VOEKL:** *Biological variation is more than random noise*
- **JAN WALLECZEK:** *Counterfactual Meta-Experimentation and the Limits of Science: 100 Years of Parapsychology as a Control Group*
- **SHIRLEY WANG:** *What does replicable 'real world' evidence from 'real world' data look like?*
- **JEVIN WEST:** *Echo Chambers in Science?*
- **YANG YANG:** *The Replicability of Scientific Findings Using Human and Machine Intelligence*
- *Funder Panel: Review and Future Directions*
- *Panel Discussion: Reflections on metascience topics and findings*
- *Panel Discussion: Journalists' perspective on metascience and engagement with the broader public*

SPEAKERS

Carl T. Bergstrom	Zoltán Kekecs	Jonathan Schooler
Dorothy Bishop	Carole Lee	Dean Keith Simonton
Annette Brown	Edward Miguel	Roberta Sinatra
Tim Errington	Staša Milojević	Paula Stephan
James Evans	Brian Nosek	Simine Vazire
Daniele Fanelli	Michèle B. Nuijten	Bernhard Voekl
Fiona Fidler	Cailin O'Connor	Jan Walleczek
Jacob Foster	Adam Russell	Shirley Wang
Andrew Gelman	Marta Sales Pardo	Jevin West
Steven Goodman	Melissa Schilling	Yang Yang

EVENT INFO

Location: Stanford University, Cubberley Auditorium

Date: 05/09 – 08/09/2019

Organizers:
Brian Nosek (Center for Open Science, USA)
Jonathan Schooler (UC Santa Barbara, USA)
Jon Krosnick (Stanford Univ., USA)
Leif Nelson (UC Berkeley, USA)
Jan Walleczek (Phenoscience Laboratories, DE)

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SPEAKER
Michèle B. Nuijten

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CHECKING ROBUSTNESS IN 4 STEPS

Michèle B. Nuijten

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Whether a published finding is robust is difficult to assess. Researchers often point at replication as a robustness check. However, conducting a replication on a new sample can cost a lot of time, effort, and money. In this talk, I propose a consecutive "four-step robustness check" that aims at the low-hanging fruit first. First, we check the internal consistency of statistical results (possibly using automated tools, such as "statcheck").

Second, we reanalyze the data using the original analytical strategy to see if the reported conclusions hold. Third, we check if the original result is robust to alternative analytical choices, for instance via a multi-verse analysis. Only then, in the fourth step, we perform a replication study on a new sample. This four-step approach allows detecting unreliable results, while wasting as little resources as possible. I will discuss potential advantages and limitations of this approach.

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MICHÈLE B. NUIJTEN

Meta-Research Center, Tilburg University

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Michèle B. Nuijten is an Assistant Professor at the Meta-Research Center at Tilburg University, where she studies reproducibility and replicability in psychology. She received her PhD in Methodology and Statistics at Tilburg University in 2018. Her PhD thesis, titled "Research on Research: A Meta-Scientific Study of Problems and Solutions in Psychological Science", was awarded the Tilburg University Dissertation Prize.

As part of her research, Michèle co-developed the free tool statcheck; a "spellchecker" for statistics. Statcheck has gained popularity as a pre-publication check: since its launch in 2016, the web app was visited tens of thousands times, and the journals Psychological Science and the Journal of Experimental Social Psychology have made statcheck a standard element in their peer-review process.

Besides her research, Michèle is closely involved with the Society for the Improvement of Psychological Science (SIPS), having been a member of the executive committee, and past-chair of the program committee. She is also part of the Program Committee Replication Research of The Netherlands Organization for Scientific Research, advising them on distributing funding for replication research.

VIDEOS WITH MICHÈLE B. NUIJTEN

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Checking Robustness in 4 Steps

PAPERS FROM MICHÈLE B. NUIJTEN

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PANEL DISCUSSION: JOURNALISTS' PERSPECTIVE ON METASCIENCE AND ENGAGEMENT WITH THE BROADER PUBLIC

Moderator:

Leif Nelson (University of California, USA)

Panelists:

Ivan Oransky (Retraction Watch, USA)

Christie Aschwanden (Emerging Form, USA)

Richard Harris (National Public Radio, USA)

Stephanie M. Lee (BuzzFeed News, USA)

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PANEL DISCUSSION: REFLECTIONS ON METASCIENCE TOPICS AND FINDINGS

Moderator:

Jon Krosnick (Stanford University, USA)

Panelists:

Jon Yewdell (NIAID/DIR, USA)

Lisa Feldman Barrett (Northeastern University, USA)

Kathleen Vohs (University of Minnesota, USA)

Norbert Schwarz (University of Southern California, USA)

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SPEAKER
Paula Stephan

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PRACTICES AND ATTITUDES REGARDING RISKY RESEARCH

Paula Stephan

Scientists are often portrayed as taking risk when it comes to designing research projects. Funding orga- nizations often list “high risk, high gain” as a top pro- gram priority and design programs to encourage risky research. Yet there is considerable evidence that cultural norms discourage risk taking, both on the part of panel members making grant decisions and on the part of scientists.
The talk will discuss evidence that re- view panels are risk averse, presenting results concer- ning 8 years of funding decisions made by the Euro- pean Research Council, and discuss factors in addition to risk aversion that may contribute to the finding. The presentation will also focus on factors that discourage risk taking among scientists such as citation practices that in the short run penalize articles that can be characterized as risky, hence discouragin

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Profile

PAULA STEPHAN

Georgia State University

Download vita

Paula Stephan is professor of economics, Georgia State University and a research associate, National Bureau of Economic Research. Her research focuses on the economics of science and the careers of scientists and engineers. Recent work examines how bibliometric measures discourage risk taking in science, the relationship between international mobility and scientific productivity, how gender pairing between student and advisor relates to the productivity of PhD recipients and the economics of the postdoctoral position. She is a Fellow of the American Association for the Advancement of Science and member of the Board of Reviewing Editors, Science. She was named ScienceCareers' first Person of the Year in 2012. Stephan is a Phi Beta Kappa Visiting Scholar for the 2018-2019 academic year.

VIDEOS WITH PAULA STEPHAN

VIDEO

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Practices and Attitudes Regarding Risky Research

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ROBERTA SINATRA

IT University of Copenhagen

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Roberta Sinatra is Assistant Professor at IT University of Copenhagen, and holds visiting positions at ISI (Turin, Italy) and Complexity Science Hub (Vienna, Austria). Her research is at the forefront of network science, data science and computational social science. Currently, she spends particular attention on the analysis and modeling of dynamics that lead to the collective phenomenon of success, with focus on science and art. Roberta completed her undergraduate and graduate studies in Physics at the University of Catania, Italy, and was first a postdoctoral fellow, then a research faculty at the Center for Complex Network Research of Northeastern University (Boston MA, USA). Her research has been published in general audience journals such as Nature and Science, and has been featured in The New York Times, Forbes, The Economist, The Guardian, The Washington Post, among other major media outlets.

VIDEOS WITH ROBERTA SINATRA

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Quantifying the evolution of scientific careers

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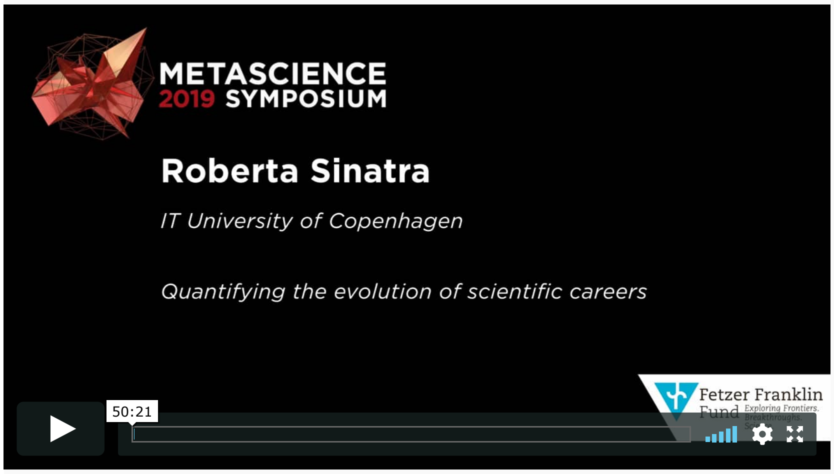
QUANTIFYING THE EVOLUTION OF SCIENTIFIC CAREERS

Roberta Sinatra



Despite the frequent use of numerous quantitative indicators to gauge the professional impact of scientists, little is known about how scientific impact emerges and evolves in scientific careers. In this talk we present a series of findings from the analysis of a large-scale dataset of scientific careers. We tackle the following three questions:
How does impact evolve in a career? What is the role of scientific chaperones in achieving high impact? How interdisciplinary is our award system?
We show that impact, as measured by influential publications, is distributed randomly within a scientist's sequence of publications, and formulate a stochastic model that uncouples the effects of productivity, individual ability, and luck in scientific careers. We show the role of chaperones in achieving high scientific impact and we study the relation between interdisciplinarity and scientific recognitions. Taken together, we contribute to the understanding of the principles governing the emergence of scientific success.

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SPEAKER
Shirley Wang

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WHAT DOES REPLICABLE 'REAL WORLD' EVIDENCE FROM 'REAL WORLD' DATA LOOK LIKE?

Shirley Wang

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Regulatory and Health Technology Assessment (HTA) organizations are increasingly looking toward use of 'real world' evidence (RWE) from 'real world' data such as administrative claims and electronic health record databases to support decision-making. Ideally, decision-makers want to focus on RWE that uses valid methodology, has transparent reporting, and generates reproducible evidence.

However, published database studies frequently do not report on key implementation parameters, making it difficult to detect flaws in design or analysis. To increase confidence in use of RWE, decision-makers need the means to effectively and efficiently distinguish between studies of high versus low validity. The REPEAT Initiative has projects focused on improving transparency, reproducibility and validity of database research. These projects include large scale replication of 150 published database studies, evaluation of robustness of results to alternative study parameters, and development of a structured reporting template with design visualization to increase transparency of reporting and minimize misinterpretation.

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SHIRLEY WANG

Harvard Medical School

Shirley Wang is an Assistant Professor of Medicine at Harvard Medical School and Associate Epidemiologist in the Division of Pharmacoepidemiology and Pharmacoeconomics at Brigham and Women's Hospital. She is a pharmacoepidemiologist focused on developing innovative, non-traditional analytic methods to understand the safety and effectiveness of medication use in clinical care as well as facilitating the appropriate use of complex methods for analyzing large observational healthcare data. To that end, she has developed enhancements to epidemiologic study designs and analytic methods as well as led efforts to guide the appropriate use of complex methods for analyzing large observational healthcare data.

Shirley has been involved with the US Food and Drug Administration's Sentinel Initiative since 2011 and her methods work has been recognized with awards from two international research societies. She recently co-led a joint task force for the International Society for Pharmacoepidemiology (ISPE) and the International Society for Pharmacoeconomics and Outcomes Research (ISPOR) focused on improving the credibility of real-world evidence for decision-makers and launched the REPEAT Initiative, a non-profit program with projects designed to improve transparency, reproducibility and ability to assess the validity of healthcare database studies. Shirley is also a writing group member for a National Academy of Medicine white paper on executing and operationalizing open science.

VIDEOS WITH SHIRLEY WANG

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What does replicable 'real world' evidence from 'real world' data look like?

PAPERS FROM SHIRLEY WANG

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What does replicable 'real world' evidence from 'real world' data look like?

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SIMINE VAZIRE

University of California at Davis

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Simine Vazire is a faculty member in the psychology department at UC Davis. She studies meta-science and research methods/practices, as well as personality psychology and self-knowledge. Vazire received her B.A. from Carleton College in 2000 and her Ph.D. from the University of Texas at Austin in 2006. She has been an editor at several journals, including Editor in Chief of Social Psychological and Personality Science from 2015 to 2019 and founding co-senior editor of the open access journal Collabra: Psychology. Together with Brian Nosek, Vazire founded the Society for the Improvement of Psychological Science (SIPS). She served as the first president of SIPS and continues to serve on the executive committee. She also serves on the board of PLOS and BITSS and was a member of the executive committee of the Association for Psychological Science. She was awarded the Leamer-Rosenthal prize for open social science from BITSS, and the APA's distinguished scientific award for early career contribution to psychology.

VIDEOS WITH SIMINE VAZIRE

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Towards a More Self-Correcting Science

PAPERS FROM SIMINE VAZIRE

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TOWARDS A MORE SELF-CORRECTING SCIENCE

Simine Vazire

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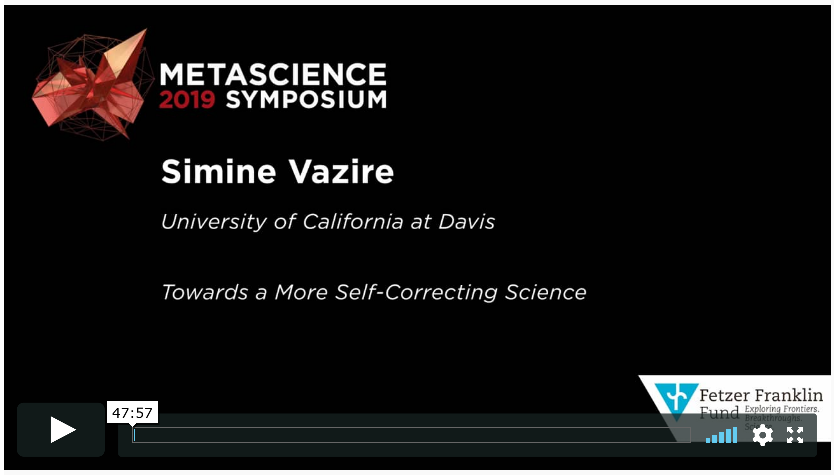

Science enjoys a great deal of public trust in part because we have a reputation for prioritizing self-correction. We teach our students that science is self-correcting, and we often repeat this when defending ourselves against critics. But what is the evidence that we really do prioritize self-correction? The prevalence of false positive findings in our top journals suggests we need better self-correction mechanisms.

What would the scientific community look like if we truly put self-correction first? First, to make errors easier to detect and correct, we would do science transparently. This is arguable one of the hallmarks of science – we should be committed to giving our critics all the ammunition they need to find our errors. Second, we would cultivate an environment where correction is valued. This would mean rewarding skepticism and criticism, rather than celebrating status and eminence.

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SPEAKER
Staša Milojević

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THE CHANGING LANDSCAPE OF KNOWLEDGE PRODUCTION

Staša Milojević

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Dramatic changes in knowledge production, exempli- fied by increased pressures on productivity, interdisciplinarity, and a shift toward „team science," are well documented, but their impact on the dynamics of an individual's scientific career and on the overall pace of science are not sufficiently understood. In this talk I will address the following questions. How did the intellectual domain of science grow over the last century? How interdisciplinary is today's science? Does interdisciplinarity increase impact? How small and large teams contribute to the expansion of the frontiers of science and how interdisciplinary are they? What effect on scientific workforce do contemporary research practices have? Are there tensions and mismatches between the scientific productions system and the scientific career system in terms of rewards, incentives, and career paths?

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Profile

STEVEN GOODMAN

Health Research & Policy, Stanford University

Steven Goodman, MD, MHS, PhD is Associate Dean of Clinical and Translational Research and Professor of Medicine and Epidemiology in the Stanford School of Medicine. He is chief of the Division of Epidemiology and directs a newly established office in the School of Medicine to improve "researcher readiness" and the reproducibility of laboratory and clinical research. He is co-founder and co-director of the Meta-research Innovation Center at Stanford (METRICS), a group dedicated to examining and improving the reproducibility, integrity and efficiency of biomedical research. His research is in the methods and philosophical foundations of statistical inference, particularly the proper measurement, conceptualization and synthesis of research evidence, with an emphasis on Bayesian approaches. He also has worked on the connections between ethics and scientific methods, particularly in interventional research. Finally, he has a strong interest in developing curricula and new models for teaching the foundations of good scientific practice.

Among his current national positions and recognitions included chairing the Methodology Committee of PCORI (Patient Centered Outcomes Research Institute), being awarded the 2016 Spinoza Chair in Medicine from the University of Amsterdam for his work in scientific and statistical inference, serving as scientific advisor to the national Blue Cross-Blue Shield technology assessment program and being senior statistical editor at the Annals of Internal Medicine, since 1987. Before coming to Stanford in 2011, he was at the Johns Hopkins Schools of Medicine and Public Health, where he directed their cancer center's Division of Biostatistics and Bioinformatics and the Dept. of Epidemiology's doctoral program.

VIDEOS WITH STEVEN GOODMAN

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Statistical methods as social technologies versus analytic tools: Implications for...

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STATISTICAL METHODS AS SOCIAL TECHNOLOGIES VERSUS ANALYTIC TOOLS: IMPLICATIONS FOR METASCIENCE AND RESEARCH REFORM

Steven Goodman

Whether a published finding is robust is difficult to assess. Researchers often point at replication as a robustness check. However, conducting a replication on a new sample can cost a lot of time, effort, and money. In this talk, I propose a consecutive “four-step robustness check” that aims at the low-hanging fruit first. First, we check the internal consistency of statistical results (possibly using automated tools, such as “statcheck”).
Second, we reanalyze the data using the original analytical strategy to see if the reported conclusions hold. Third, we check if the original result is robust to alternative analytical choices, for instance via a multi-verse analysis. Only then, in the fourth step, we perform a replication study on a new sample. This four-step approach allows detecting unreliable results, while wasting as little resources as possible. I will discuss potential advantages and limitations of this approach.

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BARRIERS TO CONDUCTING REPLICATIONS – CHALLENGES OR OPPORTUNITIES?

Tim Errington

A number of studies have shown that engaging in scientific teams has the potential of boosting the impact of the research results independently of the field.
However, the way scientists engage in such collaborations is affected by many factors including gender and funding. In this talk I will discuss how these two factors affect collaboration patterns using results derived form two studies: a gender study of scientists in top US universities in different fields of science and a study of top-performing scientists across continents and scientific fields.

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Profile

TIM ERRINGTON

Tim Errington is the Director of Research at the Center for Open Science (COS), a non-profit organization in Charlottesville, Virginia, USA that has a mission to increase openness, integrity, and reproducibility of scientific research. In this role, Tim collaborates with researchers and stakeholders across scientific disciplines and organizations on projects aimed to understand the current research process and to evaluate initiatives designed to increase reproducibility and openness of scientific research. Tim earned a B.S. degree in both Biology and Chemistry from St. Lawrence University, an M.A. in Molecular and Cell Biology from the University of California at Berkeley, and a Ph.D. in Microbiology, Immunology, and Cancer Biology from the University of Virginia.

VIDEOS WITH TIM ERRINGTON

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Barriers to conducting replications - challenges or opportunities?

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[Reproducibility Project: Cancer Biology – Barriers to Replicability in the Process of Research]

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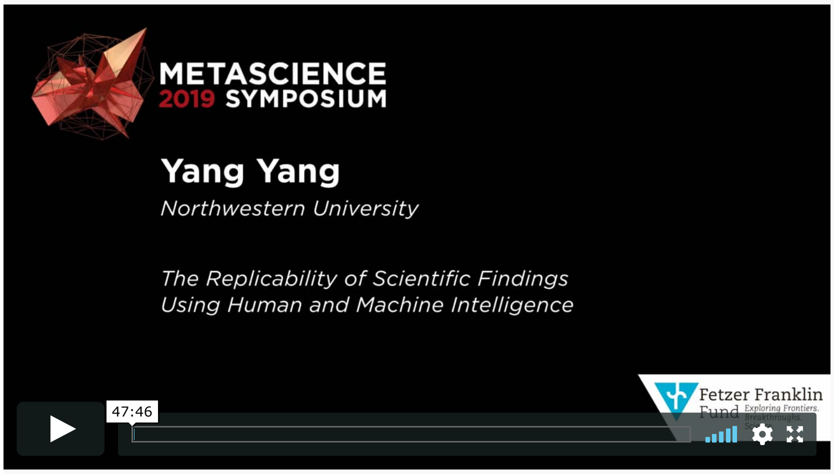
THE REPLICABILITY OF SCIENTIFIC FINDINGS USING HUMAN AND MACHINE INTELLIGENCE

Yang Yang



In top journals, more papers fail than pass replication tests and papers failing replications spread as widely as replicating papers. This dynamic raises research costs by over 20bn annually, jeopardizes the literature, and exposes the need for new methods for predicting replicability. Using 96 studies that underwent rigorous manual replication, we developed an artificial intelligence (AI) model that predicts a paper's replicability. We then tested the model on 317 diverse out-of-sample studies that span disciplines, methods, and topics.
We find that AI predicts replicability better than statistics and individual reviewers and as accurately as prediction markets, the gold standard of replicability methods. Further, AI generalizes to out-of-sample data at AUC levels up to 0.78. Finally, tests indicate that the AI model does not show biases common to human reviewers. We discuss how AI can address replication problems at scale in ways that current methods cannot and can advance research by combining human and machine intelligence.

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YANG YANG

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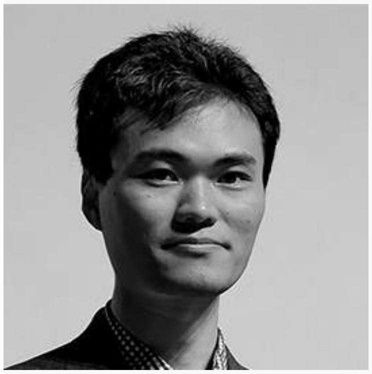

I am a Research Assistant Professor at the Kellogg School of Management, Northwestern University. My principal research interest lies in the area of data mining/machine learning, computational social science and science of science. I study the link between the social network and leadership attainment and how social network can help women to achieve placement in leadership. Based on organizational theory, I develop a model for estimating a terror group's future lethality by inferring from latent variables its hidden capabilities and resources. This model has an unique early warning signals. I also test the ability of artificial intelligence to address the replication problem in science. The goal is to demonstrate how AI can address replication problems at scale in ways that current methods cannot and can advance research by combining human and machine intelligence.

VIDEOS WITH YANG YANG

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The Replicability of Scientific Findings Using Human and Machine Intelligence

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SPEAKER
Zoltán Kekecs

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HOW TO PRODUCE CREDIBLE RESEARCH ON ANYTHING

Zoltán Kekecs

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How can we trust research produced by others, and how can we show others that the research we produce can be trusted? What would it take for you to trust a re- sult that directly contradicts your prior beliefs? A host of credibility enhancing approaches will be discussed including crowdsourced research design, automation, trusted third party oversight, tamper evident seals on data and software, documented training, lab logs, and radical transparency about the whole research pipeline. These techniques and their consequences are pre- sented in the context of a massive multilab replication of one of Bem's 2011 parapsychology experiments investigating human precognitive abilities that shocked psychological science and contributed to the initiation of the reformist movement on the field.

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Profile

ZOLTÁN KEKECS

Department of Psychology, Lund University

Zoltan Kekecs is an assistant professor at ELTE. Earlier he worked as a post-doctor at Baylor University, Department of Psychology and Neuroscience; at Imperial College London, Patient Safety Translational Research Centre, and at Lund University, Institute of Psychology. His research focuses on the efficacy and underlying psychophysiological mechanisms of medical hypnosis. He also leads the ELTE and Lund Research Credibility Workgroups, aiming to develop tools and methodologies that can enhance the credibility of research in psychological science. His professional accomplishments have been recognized by the Early Career Achievement Award from the American Society of Clinical Hypnosis. He is also active in professional societies: Since 2018 he is a methodologist and member of the Data and Methods Committee of the Psychological Science Accelerator, and he is an elected officer of the Society for Clinical and Experimental Hypnosis. Earlier he was the treasurer of the American Psychological Association Division 30.

VIDEOS WITH ZOLTÁN KEKECS

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How to produce credible research on anything

PAPERS FROM ZOLTÁN KEKECS

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How to produce credible research, on anything

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NAME
2nd International Conference on Neuroscience and Free Will

DATE
14/03 - 18/03/2019

VENUE
Chapman University, CA, USA

FIELD OF SCIENCE
Consciousness

WEBSITE
https://braininstitute.us/news/free-will-conference

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2ND INTERNATIONAL CONFERENCE ON NEUROSCIENCE AND FREE WILL

14/03 – 18/03/2019, Chapman University, CA, USA

The First International Conference on the Neuroscience of Free Will was held in the summer of 2017 at the Sigtuna Foundation in Sweden, also sponsored by the Agora for Biosystems. As we continue to learn about the neural processes underlying volition, decision-making, and action formation, we announce the Second International Conference on the Neuroscience of Free Will, which will be held in Southern California, around Chapman University's new Institute for Interdisciplinary Brain and Behavioral Sciences, from Thursday, March 14, in the afternoon to Monday, March 18, 2019, at noon. There, we will retake stock of the field and revisit challenges and promising pathways forward.

This conference has been made available by the generous support of the Fetzer Franklin Fund and additional support from the President's Office and Crean College at Chapman University.

For more information, or for help with registration, please contact fetzer@elementsmeetings.com or go to eiseverywhere.com/ehome/neuroscienceandfreewill.

Conference organizer

Uri Maoz, PhD

Registration

You can register for this program by clicking "Register Now".

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NAME
EmQM19/20 - Emergent Quantum Mechanics

DATE
25/10 - 27/10/2019

VENUE
Postponed To October 2020

FIELD OF SCIENCE
Foundations, Physics

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EMQM19/20 – EMERGENT QUANTUM MECHANICS

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05/09 – 08/09/2019

METASCIENCE 2019 SYMPOSIUM – THE EMERGING FIELD OF RESEARCH ON THE SCIENTIFIC PROCESS

Stanford University, Cubberley Auditorium

During this decade, we have witnessed the emergence of a new discipline called metascience, metaresearch, or the science of science. Most exciting is the fact that this is emerging as a truly interdisciplinary enterprise with contributors from every domain of research. This symposium serves as a formative meeting for metascience as a discipline. The meeting will bring together leading scholars that are investigating questions related to themes.

Explore the event

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Consciousness

14/03 – 18/03/2019

2ND INTERNATIONAL CONFERENCE ON NEUROSCIENCE AND FREE WILL

Chapman University, CA, USA

The First International Conference on the Neuroscience of Free Will was held in the summer of 2017 at the Sigtuna Foundation in Sweden, also sponsored by the Agora for Biosystems. As we continue to learn about the neural processes underlying volition, decision-making, and action formation, we announce the Second International Conference on the Neuroscience of Free Will, which will be held in Southern California, around Chapman University's new Institute for Interdisciplinary Brain and Behavioral Sciences, from Thursday, March 14, in the afternoon to Monday, March 18, 2019, at noon. There, we will retake stock of the field and revisit challenges and promising pathways forward.

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For more information, or for help with registration, please contact fetzer@elementsmeetings.com or go to eiseverywhere.com/ehome/neuroscienceandfreewill.

Conference organizer

Uri Maoz, PhD

Registration

You can register for this program by clicking "Register Now".

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2017

Foundations, Physics

26/10 – 28/10/2017

EMQM17 – TOWARDS ONTOLOGY OF QUANTUM MECHANICS AND THE CONSCIOUS AGENT

University of London, Senate House, Beveridge Hall

On the occasion of David Bohm's 100th birthday, the EmQM17 Symposium offered an open forum for critically evaluating the prospects and significance - for 21st century physics - of ontological quantum mechanics, an approach which David Bohm helped pioneer. Contributions were invited that presented current advances in both standard as well as realist approaches to quantum mechanics, including new experiments, work in quantum foundations, and quantum philosophy.

Explore the event

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2015

Foundations, Physics

23/10 – 25/10/2015

EMQM15 – EMERGENT QUANTUM MECHANICS

Vienna University of Technology

The symposium "EmQM15 – Emergent Quantum Mechanics" invites the open exploration of the quantum state as a reality. The resurgence of interest in ontological quantum theory, including both deterministic and indeterministic approaches, challenges long held assumptions and directs focus towards the following questions:

- Is the world local or nonlocal? What is the nature of quantum nonlocality?
- If nonlocal, i.e., superluminal, influences exist then why can't they be used for superluminal signalling and communication?
- How is the role of the scientific observer/agent to be accounted for in realistic approaches to quantum theory?
- How could recent developments in the field of space-time as an emergent phenomenon advance new insight at this research frontier?
- What new experiments might contribute to new understanding?

These and related questions will be addressed in the context also of a possible "deeper level theory" for quantum mechanics that interconnects three fields of knowledge: emergence, the quantum, and information. Could there appear a revised image of physical reality from recognizing new links between emergence, the quantum, and information? The symposium provides a forum for considering (i) current theoretical and conceptual obstacles which need to be overcome as well as (ii) promising developments and research opportunities on the way towards realistic quantum mechanics. Contributions are invited that present current advances in both standard as well as unconventional approaches.

Explore the event

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2013

Foundations, Physics

03/10 – 06/10/2013

EMQM13 – EMERGENT QUANTUM MECHANICS

Austrian Academy of Sciences, Vienna

The symposium invites the open exploration of an emergent quantum mechanics, a possible "deeper level theory" that interconnects three fields of knowledge: emergence, the quantum, and information. Could there appear a revised image of physical reality from recognizing new links between emergence, the quantum, and information? Could a novel synthesis pave the way towards a 21st century, »super-classical« physics? The symposium provides a forum for discussing (i) important obstacles which need to be overcome as well as (ii) promising developments and research opportunities on the way towards an emergent quantum mechanics. Contributions are invited that present current advances in both standard as well as unconventional approaches to quantum mechanics.

Our symposium was open to the public, with free attendance.

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2012

Consciousness, Foundations

19/10 – 23/10/2012

THE DECLINE EFFECT: EVIDENCE, EXPLANATIONS, AND FUTURE DIRECTIONS

University of California, Santa Barbara

A Symposium at the University of California, Santa Barbara, co-organized by Jonathan Schooler and Jan Walleczek, and sponsored by the Fetzer Franklin Fund. The participants sought advances in understanding how various scientific practices may negatively impact the search for truth and objectivity, and how the development of new protocols and open-access methodologies might best address the current reproducibility crisis in science.

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Info

NAME
The Decline Effect: Evidence, Explanations, and Future Directions

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